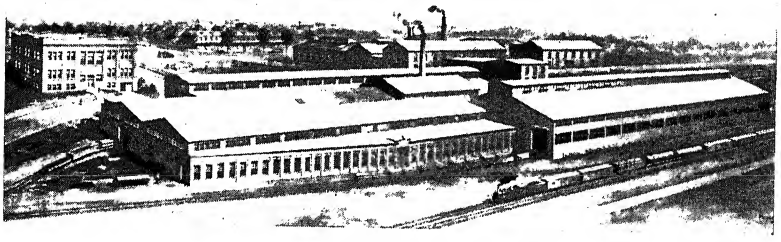
LANCASTER HAND BOOK

General data useful in connection with the design and fabrication of

STEEL PLATE CONSTRUCTION

PRESSURE VESSELS, SMOKESTACKS,
STORAGE TANKS, BINS, TOWERS,
DREDGE PIPE, HULLS, BARGES, ETC.



LANCASTER IRON WORKS, INC.
General Office and Works
LANCASTER, PA.
122 East 42nd St.
NEW YORK, N. Y.

THIRD EDITION

Joseph Savko

SEVEN (7) POINTS OF SUPERIORITY OF LANCASTER TANKS

1. SAFETY FACTOR

All Lancaster Tanks are built in every way to a liberal Factor of Safety. They are tested to a considerable excess over the normal working pressure, they are fabricated in strict accordance with required insurance, municipal or state requirements and guaranteed absolutely tight for the purpose intended.

2. QUALITY OF STEEL

Only high grade Steel, rolled to definite specifications and with a high tensile strength, is used in Lancaster Tanks. Copies of test reports, with physical and chemical analyses, furnished to customers when desired.

3. FULL WEIGHT MATERIAL

All plates used in the construction of Lancaster Tanks are ordered to specific thickness, insuring full-weight material throughout and making a heavier, more durable job than usually furnished by many shops and giving customers a little more than they usually expect or frequently get.

4. JOINTS

Lancaster Tanks are electric welded by qualified welders, using modern equipment. Edges of plates are properly prepared, the correct electrodes are used and the results produce neatly finished joints of great strength and ductility.

Results of tests show an unusually high degree of joint efficiency in the uniformly, dependable joints of Lancaster Tanks.

5. APPURTENANCES

Manhole frames and covers, pipe openings or other fittings on Lancaster Tanks are always of heavy, durable construction. Openings are reinforced wherever necessary, whether specified or not. Fittings are securely and safely fastened to tanks and all openings suitably plugged before tanks are shipped, to prevent moisture or dirt entering tanks.

6. DURABILITY

Lancaster Tanks for every purpose are carefully designed by Lancaster Engineers, just as carefully fabricated of full-weight, high-quality steel; the high efficiency joints are uniform and dependable and the finished tanks constitute the highest type of products on the market, easily outlasting tanks of inferior material and workmanship.

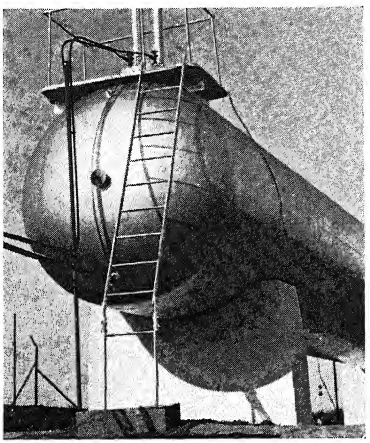
7. SERVICE

At Lancaster you will enjoy the benefits of a Well-trained Organization—Experienced Shop Personnel—Competent Field Crews—Convenient Railroad Facilities—all linked into a Self-contained Unit ready to handle your wants without Delay.

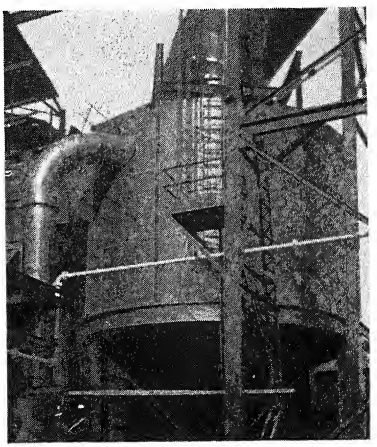
SEND US YOUR TANK PROBLEMS—
NO MATTER WHAT THEY ARE, *LANCASTER* CAN HELP YOU.

UNUSUAL STEEL PLATE CONSTRUCTION

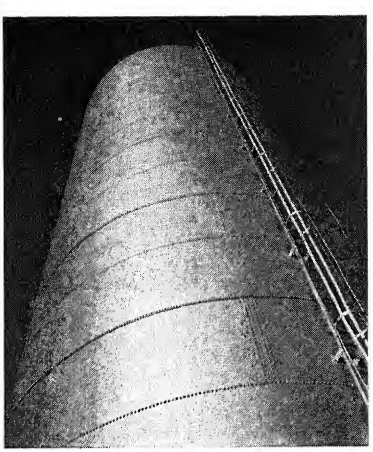
Welded or Riveted Tank and Plate Work
Shop-built or Erected Anywhere



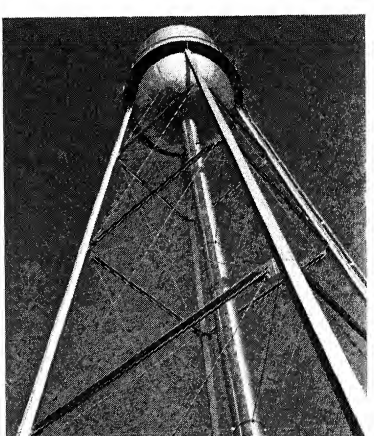
Large Capacity, High Pressure
Propane Gas Tank



Dust Bin with Supports
and Piping



Water Standpipe Over
100 Ft. High



Elevated Sprinkler Tank
on 100 Ft. Tower

Wherever there is a use for Steel Plate Construction in the Industrial or Process Industries—Lancaster has an established reputation for dependability and service.

LANCASTER PRODUCTS

Absorbers
Accumulators
Acid Eggs
Acid Tanks, Nitric, Sulphuric, etc.
Agitators, Oil, Chemical, etc.
Air Ducts
Air Locks, Shafting, etc.
Air Tanks
Alcohol Tanks
Alloy Metal Tanks and Plate Work
Aluminum Tanks
Ammonia Tanks
Annealing Boxes
Asphalt Tanks and Stills
Autoclaves

Ball Joints, for Dredge Pipe
Barge Tanks
Barges, Hulls, etc.
Barometric Condensers
Beer Tanks, Storage, Fermenting, etc.
Benzol Washers
Bins, for Dry or Liquid Storage
Blast Furnace Shells and Piping
Bleaching Tanks
Blowoff Tanks
Breechings
Brew Kettles
Brick Machinery
Brine Tanks
Bubble Towers
Bulk Plant Tanks
Bunkers
Butane Tanks

Caissons
Car Tanks
Castings, Iron
Catamarans
Caustic Tanks
Cement Bins and Kilns
Charging Boxes
Chemical Tanks and Plate Work
Chutes
Clarifiers
Coal Bunkers
Coal Gas Storage Tanks
Compartment Tanks
Compressed Air Tanks
Concentrators
Condensers
Containers, for Dry or Liquid Storage
Cookers
Cooling Tanks and Towers
Copper Bearing Steel Stacks and Tanks
Copper Clad Steel Tanks
Corrosion Resistant Plate Work
Creosoting Retorts
Crude Oil Stills
Crystallizers
Cupolas
Cylinder and Tank Shells

Dairy Tanks
Denitrators
Dephlegmators
Devulcanizers
Diffusers
Digesters
Dipping Tanks
Distillery Tanks, Dryers, etc.
Downcomers
Dredge Hulls
Dredge Pipe
Dryer Shells
Dust Collectors and Flues

Elevated Tanks
Elevator Tanks
Evaporators
Everdur Tanks
Expansion Tanks
Extractors

Feed Water Tanks
Fermenting Tanks
Field Storage Tanks
Filling Station Tanks
Filter Tanks
Freezing Tanks
Flues
Flumes
Forms
Fuel Oil Tanks
Fusion Pots

Galvanized Tanks
Galvanizing Tanks
Gas Mains
Gas Tanks
Gasoline Tanks
Gasometers
Gate Valves for Dredge Pipe
Glass-lined Tanks
Grain Tanks
Graphite Tanks
Gravity Tanks
Grease Tanks

Hearth Jackets
Heater Tanks
Hop Jacks
Hoppers
Horizontal Tanks
Hot Water Tanks
House Tanks
Hydraulic Mains
Hydro-Pneumatic Tanks

Ice Tanks and Pans

Jacketed Tanks and Kettles

Kettles, Brewing, Chemical, Varnish, etc.
Kettles, Jacketed
Kiers
Kilns
Knocked Down Tanks

Land Pipe
Lard Tanks
Lead-lined Tanks
Liquefied Petroleum Gas Tanks
Lime Tanks and Bins
Linseed Oil Tanks

Mixing Tanks
Molasses Tanks
Monel Metal Tanks

Naphtha Storage Tanks
Nickel Clad Steel Tanks
Nickel Tanks and Plate Work
Nitrators

Oil Refinery Equipment
Oil Storage Tanks
Ore Bins

Packing House Tanks
Paint Storage and Mixing Tanks
Paper Mill Tanks
Paraffine Tanks
Penstocks
Pickling Tanks
Pipe, Dredge
Pipe Elbows
Pipe, Pressure
Pipe, Steel Mill, etc.
Pipe, Welded or Riveted
Pontoon Cylinders
Pontoon Pipe
Pressure Tanks
Process Tanks
Propane Tanks
Purifier Boxes

Quenching Tanks

Railroad Tanks
Receiving Tanks
Rectangular Tanks
Reducers
Refinery Construction
Rendering Tanks
Retorts
Riveted Tanks, Pipe and Plate Work
Rotary Dryers
Rubber-lined Tanks

Saturators
Scale Boxes
Scroll Casings
Scrubbers
Sedimentation Tanks
Separator Tanks
Settling Tanks
Shore Pipe
Sludge Tanks
Soap Tanks
Sprinkler Tanks
Stacks, Guyed or Self Supporting
Stainless Clad Tanks
Stainless Steel Tanks and Plate Work
Standpipes
Starch Tanks
Starting Air Tanks
Station Tanks
Steel Plate Construction
Stills, Asphalt, Kerosene, Tar, etc.
Storage Tanks, Shop-built or Field-erected
Sugar Tanks
Sulphonators
Sump Tanks
Surge Tanks
Syrup Tanks

Tannery Tanks
Tar Storage Tanks
Towers, Bubble, Fractionating, etc.
Towers, Tank
Troughs
Tunnel Shields
Turpentine Tanks

Underground Tanks

Vacuum Tanks
Varnish Tanks and Kettles
Vats
Vertical Tanks
Vessels of Steel or Alloy Plate Construction
Vulcanizers

Water Boxes
Water Softeners
Water Storage Tanks
Welded Tanks, Pipe and Plate Work
Well Casing
Wine Tanks
Wrought Iron Stacks, Tanks, Pipe, etc.

STEEL PLATE SPECIFICATIONS

Steel Plates may be fabricated from various specifications as desired by the customer and we will furnish plate work to the physical and chemical requirements of any standard plate specifications, or to the private specifications of individual customers, provided the standard permissible range of physical and chemical properties are permitted.

Carbon Steels can be furnished in tensile strengths from 45,000 pounds to 85,000 pounds per square inch with corresponding elasticity, reduction of area, elongation, etc., and to chemical analyses within reason, compatible with required physical properties.

High-strength Steels having an ultimate tensile strength over 85,000 pounds per square inch can also be fabricated to special requirements. These Steels include Nickel, Vanadium, Silicon, Chromium, etc., and combinations of various elements depending upon the application or purpose intended.

CLASSIFICATIONS

As a matter of general information on plates used in tank work and general riveted or welded construction, we offer a partial list of the most commonly used specifications and descriptions:

TANK STEEL

Tank Steel plates were for a long period commonly used in steel plate fabrication, and yet for many years no universally definite specifications were in force. Steel mills generally roll Tank Steel as Mild Steel Plates coinciding with A. S. T. M. specifications, or those of the Association of American Steel Manufacturers. For non-code work, such specifications as A. S. T. M. A 10-39 are frequently used.

PRESSING STEEL

Pressing Steel is a quality of plate steel made for ordinary hot pressing, flanging or bending work, and is usually specified for tank heads, when code requirements are unnecessary, or where Flange Steel can be eliminated and no extreme pressures or stresses are required.

FLANGE STEEL

Flange Steel is the standard of the low carbon steels and is made from carefully selected stock, low in chemical impurities and especially adapted to stand without injury, the heating, forming, bending, etc., required in fabricating high-pressure vessels or complicated plate work. Flange Steel is specified by the A. S. M. E. Code for Unfired Pressure Vessels and is furnished with a minimum tensile strength of 55,000 lbs. to 65,000 lbs.

Standard specifications for Boiler or Flange Steel are covered by A. S. T. M. A 70-39. This steel is suitable for fusion welding or riveting.

FIREBOX STEEL

Ordinary Firebox Steel is only slightly different from Flange Steel and is prepared with great care to secure freedom from chemical impurities and to obtain density and fineness of texture. It is especially fitted to stand unequal strains of fire and water actions. A. S. T. M. A 70-39 specifications cover this steel.

LOCOMOTIVE FIREBOX STEEL

This Steel is made for conditions requiring direct heat and great pressures and varies slightly in order to comply with the rigid specifications adopted by different railroads or associations. A. S. T. M. specifications A 30-39.

LOW TENSILE STRENGTH FLANGE AND FIREBOX STEEL.

These specifications cover grades of carbon-steel plate for pressure ves-

sels and boilers, suitable for fusion welding, also for forge welding when specified before rolling at the mill. A. S. T. M. A 89-39.

MILD STEEL PLATES

These specifications cover a mild grade of steel suitable for general plate construction. A. S. T. M. A 10-39.

HULL, MARINE OR U. S. NAVY STEELS

These Steels are all that their names imply and made especially to meet the stringent requirements of the U. S. Navy, American Bureau of Shipping, Lloyds, etc. They are not used in ordinary tank work or plate fabrication, but frequently specified for use in connection with U. S. Government or ocean vessel requirements.

A typical specification is structural steel for ships—A. S. T. M. A 131-39.

STRUCTURAL NICKEL STEEL

High strength structural nickel steel plates and shapes are covered by these specifications. A. S. T. M. A 8-39.

CHROME-MANGANESE-SILICON (C.M.S.) ALLOY STEEL PLATES

This steel in Grade B is a high tensile steel with a minimum of 85,000 pounds per square inch tensile strength and has sufficient ductility to be workable without heating. On vessels operating under high pressures by use of this steel there is often a considerable saving in thickness and weight of material. A. S. T. M. A 202-39.

COPPER BEARING STEEL

Copper Bearing Steel enjoys a wide use and the addition of small amounts of copper, as from .15% to .20%, increases the ductility of Steel, aids in retarding corrosion and insures longer wear under some conditions.

Sulphur in Steel accelerates the corrosion very markedly and Sulphur oxides in the air accelerate the corrosion of Steel, but Copper, in Steel, counteracts or retards both corroding influences.

Copper Bearing Steel is used mainly in outdoor tank, pipe or stack work and where a cheap anti-corrosive metal is specified.

IRON PLATES—OPEN HEARTH FLANGE QUALITY

Iron plate is notable for toughness, ductility, malleability and weldability. It is useful against atmospheric and underground corrosion conditions and is used extensively in pipe, stack and ship construction.

A. S. T. M. specifications A 129-39.

TONCAN IRON

Toncan Iron combines some of the corrosion-resisting advantages of Genuine Wrought Iron with slight additional tensile strength. It is known as a Copper Bearing Iron and is successfully used in refinery construction, particularly for fractionating towers, agitators, etc., or wherever corrosive conditions are rather severe.

EVERDUR

Everdur is largely Copper but with the addition of Silicon and Manganese, the result is a metal with the strength of Steel and unusual resistance to a large number of corroding agents as sulphuric acid, alum salt solutions, various sulphates, brine solutions, sea water, calcium chloride, oxalic, phosphoric, citric, lactic and many other acids.

PURE NICKEL

Nickel used in vessels or piping, represents one of the leading anti-corrosion metals. Nickel is extremely resistant to alkalis and a wide range

of salts. It is especially useful in caustic, food and dairy product equipment and is used in rayon, cellophane, drug and perfumery manufacture.

MONEL METAL

Monel Metal is a Nickel-Copper alloy and is resistant to a wide range of corrosive conditions. It combines great strength, ability to stand abrasion, impact and fatigue and resistance to high temperatures. Monel Metal is unaffected by many acids and is used considerably in dyestuff manufacture, rubber, paper and other process industries.

ALUMINUM

Aluminum Alloy Plates are often used for fabricated plate work and a number of combinations are available, varying in degrees of hardness and elasticity, etc.

Aluminum is one of the most non-corrodible metals and is suitable for use with many acids, also with animal oils, crude oil distillation products, celluloid, dairy products, food products, fruit juices, gasoline, glycerine, naval stores, rayon, soaps, textiles, varnish, etc.

STAINLESS STEELS

Exceptional resistance to most forms of corrosion, coupled with very high tensile properties, characterizes Stainless Steel. Although manufactured in various grades for different purposes, probably the most popular combination for plate fabrication is the "18 and 8" specification containing 18 to 20% Chromium and 8 to 10% Nickel.

Stainless Steel is used with nitric, picric, acetic, hydrochloric, tannic and many other acids, also with sodium, ammonium, potassium, mercuric and other salts, also for fruit juices, milk, soap, vinegar, brines, etc.

STAINLESS CLAD STEEL

A Stainless Steel Cladding (10% to 20%) over mild or low carbon steel. The coating is bonded to the steel, forming a solid metal. It has a tensile strength of 55,000 pounds and the same anti-corrosive properties (on face side) as solid Stainless Steel.

NICKEL CLAD STEEL

A pure Nickel cladding (10% to 20%) over mild or low carbon steel. The coating is bonded to the steel, forming a solid metal. It has a tensile strength of 55,000 pounds and the same anti-corrosive properties (on face side) as pure Nickel.

ABRASION-RESISTING STEEL

This steel, which is prepared particularly for use where resistance to abrasive wear is the chief concern, is used very successfully in bins, hoppers, chutes, pipe, etc., handling sand, gravel, coke, cinders, ore and other abrasive materials.

L. I. W. SPECIAL ANALYSIS PIPE STEEL

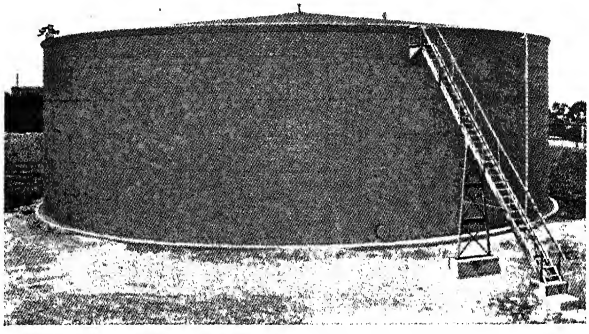
In dredging rivers, channels, ocean harbors, etc., the erosive action of material handled and the corrosive influence of salt water, both have severe effects on dredge pipe made of ordinary steel plate. From our own long experience, we have developed a Special Analysis Steel, highly successful for use in dredging and insuring greater value and long service on the job.

GENERAL

It is impossible to describe all of the many varieties of plate steels, alloy or special metals in this publication, but we have listed most of the commonly used kinds.

We are familiar with all the various available plate metals and can fabricate products of these metals to your specifications or requirements.

FIELD STORAGE TANKS



Lancaster is especially equipped to design, manufacture and erect Field Storage Tanks for practically every storage purpose. Tanks for petroleum oils, gasoline, vegetable oils, fish oils, molasses, acids, alcohol, etc., are built of the proper material and design, to a recommended factor of safety and guaranteed for the purpose intended.

TANKS FROM 240 BARRELS TO 134,000 BARRELS CAPACITY

SPECIAL TANKS of any size are designed, fabricated and erected to meet special storage conditions and specifications. In special work, give the following information: Use; Capacity; Height; Erection conditions at proposed site; Distance from nearest railroad siding; Availability of power, water, etc.

Lancaster Engineers will be glad to assist you with any problems you may have pertaining to Field Storage Tanks of large capacity or unusual storage or construction conditions.

ALL-RIVETED STORAGE TANKS

ALL-WELDED STORAGE TANKS,

RIVETED TANKS WITH WELDED ROOFS AND BOTTOMS

BUILT TO A. P. I. SPECIFICATIONS

For sizes and capacities, see following pages.

AMERICAN PETROLEUM INSTITUTE STANDARD VERTICAL STORAGE TANKS

We are approved manufacturers of A. P. I. Specification Storage Tanks and can furnish either Riveted or Welded Tanks to these specifications.

Lack of space does not permit listing of complete details, but as a matter of general information we list general sizes and capacities of the various tanks.

RIVETED

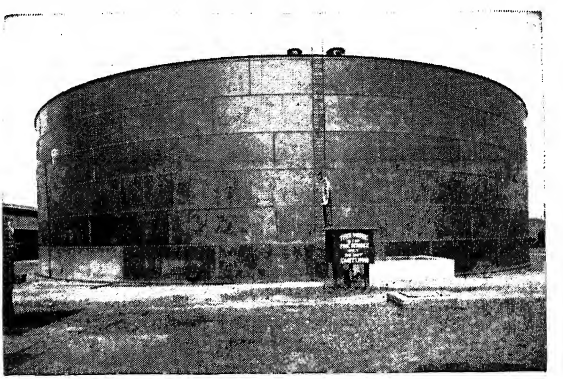
DIAMETER (Feet)	NOMINAL HEIGHT (Feet)						
	12	17¾	23½	29½	35	40½	46
	NUMBER OF COURSES						
	2	3	4	5	6	7	8
12	240	360	480	590	720	.....	.....
18	540	810	1,070	1,340	1,600	.....	.....
24	960	1,440	1,910	2,380	2,850	.....	.....
30	1,500	2,240	2,980	3,710	4,450	.....	.....
36	2,160	3,400	4,300	5,400	6,400	7,400	8,400
48	3,850	5,730	7,600	9,500	11,300	13,200	15,000
60	5,960	8,880	11,800	15,000	17,500	20,500	23,500
78	.....	.....	.....	25,000	30,000	35,000	39,500
102	.....	.....	.....	42,500	51,000	59,000	68,000
120	.....	.....	.....	59,000	70,000	82,000	93,000
144	.....	.....	.....	85,000	101,000	118,000	134,000

Table Giving Sizes of Tanks with Riveted Shells

Roof Plates can be furnished Riveted or Welded. Bottom Plates also may be furnished either Riveted or Welded construction.

Shell Plates have an overall width of 72 inches and the number of Plates in each course is equal to the diameter of the Tank divided by 6.

TABLE CAPACITIES BASED ON 42-GALLON BARRELS



AMERICAN PETROLEUM INSTITUTE STANDARD VERTICAL STORAGE TANKS

WELDED

DIAMETER (Feet)	NOMINAL HEIGHT (Feet)						
	12	18	24	30	36	42	48
	NUMBER OF COURSES						
	2	3	4	5	6	7	8
12	240	360	480	600	730	.....	.....
18	540	820	1,090	1,360	1,630	.....	.....
24	970	1,450	1,940	2,420	2,910	.....	.....
30	1,510	2,270	3,020	3,780	4,540	.....	.....
36	2,180	3,270	4,360	5,440	6,530	7,620	8,700
48	3,870	5,800	7,740	9,680	11,610	13,540	15,480
60	6,048	9,070	12,100	15,120	18,140	21,165	24,190
78	.....	.....	.....	25,550	30,660	35,770	40,880
102	.....	.....	.....	43,700	52,430	61,170	69,910
120	.....	.....	.....	60,480	72,575	84,670	96,765
144	.....	.....	.....	87,090	104,500	121,920	139,340

Tank Sizes—72″ Courses

WELDED

DIAMETER (Feet)	NOMINAL HEIGHT (Feet)				
	16	24	32	40	48
	NUMBER OF COURSES				
	2	3	4	5	6
12	320	480	640	.....	.....
18	730	1,090	1,450	.....	.....
24	1,290	1,940	2,580	.....	.....
30	2,020	3,020	4,030	.....	.....
36	2,900	4,360	5,800	7,260	8,700
48	5,160	7,740	10,320	12,900	15,480
60	8,060	12,100	16,120	20,160	24,190
78	.....	.....	27,260	34,070	40,880
102	.....	.....	46,610	58,260	69,910
120	.....	.....	64,510	80,640	96,765
144	.....	.....	92,900	116,120	139,340

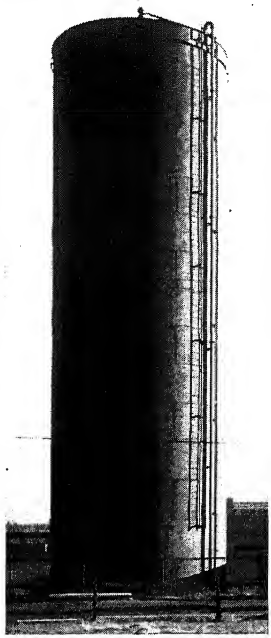
Tank Sizes—96″ Courses

TABLE CAPACITIES BASED ON 42-GALLON BARRELS

For further details, consult American Petroleum Institute Specifications or apply to us.

A. P. I. STANDARD TANKS BUILT AND ERECTED BY L. I. W.

WATER STANDPIPES



Standpipe 30′ dia. x 95′ high

When a City, a Village or an Industrial Plant buys a Standpipe, they don't want to worry about the proper design or how it should be fabricated. Our long experience enables us to satisfy the most exacting demands and specifications. We erect with our own crews and equipment and can furnish Standpipes of Iron or Steel Construction, or of Copper-bearing Steel, if desired.

STANDPIPES should be Correctly Designed, Carefully Built and Properly Erected

Lancaster Standard
1,000,000 gallon Standpipe
can be furnished in varying diameters and heights.

Standpipes of any size, shape or style, designed to municipal, insurance or other regulations, built by Lancaster and erected anywhere.

Standpipe with Spiral Stairway and Ornamental Roof

HYDRO-PNEUMATIC STORAGE TANKS

We manufacture a complete line of non-code tanks, either in riveted or welded construction, for pressures from 50 lbs. to 150 lbs. per square inch. The sizes listed below give over-all sizes required in connection with various capacities.

Upon application, we will be glad to quote on tanks to any size or pressure.

Nominal Capacity in Gallons	Outside Diameter	Approx. Overall Length	Nominal Capacity in Gallons	Outside Diameter	Approx. Overall Length
550	36″	10′-11″	3,000	72″	17′-8″
780	42″	11′-4″	5,000	72″	24′-5″
1,030	42″	14′-0″	7,500	72″	36′-3″
1,035	48″	11′-8″	5,000	84″	18′-6″
1,500	48″	16′-10″	7,500	84″	27′-2″
2,000	48″	22′-0″	10,000	84″	35′-10″
2,500	60″	18′-0″	5,000	96″	14′-6″
3,000	60″	21′-4″	7,500	96″	21′-4″
3,500	60″	24′-7″	10,000	96″	27′-8″
4,000	60″	27′-11″	15,000	96″	41′-2″

Note: 36″-42″-48″ diameter tanks ordinarily furnished with one head inverted and no manhole.

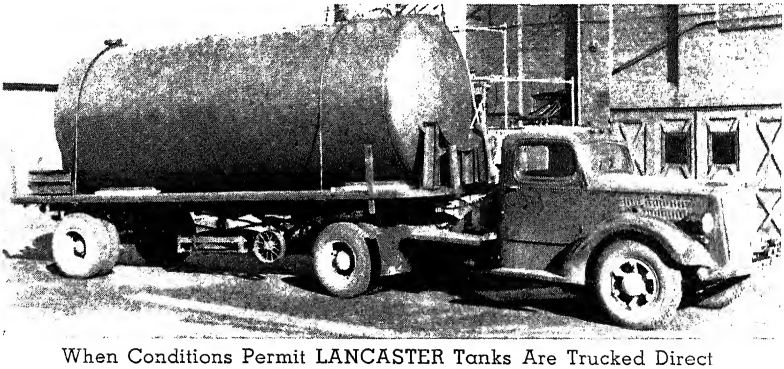
Manholes may be furnished in small diameter tanks, if wanted. Tanks 60″ diameter and over furnished with manhole in one head.

TYPICAL OPENINGS FOR HYDRO-PNEUMATIC TANKS

Diameter of Tank	30″	36″	42″	48″	60″	72″	84″	96″
Gage Glass Openings	½″	½″	½″	½″	½″	½″	½″	½″
Standard Openings	1¼″	1½″	2″	2″	3″	3″	6″	6″
Cent. to Cent. of Single Gage Glass Openings	15½″	17½″	21½″	25½″	31½″	—	—	—

SPECIAL OPENINGS—When extra or special openings are wanted, advise number, size and location.

MANHOLES—When desired, advise location, in shell or heads.



When Conditions Permit LANCASTER Tanks Are Trucked Direct to Destination

HYDRO-PNEUMATIC STORAGE TANKS

SHELL AND HEAD THICKNESSES REQUIRED FOR STANDARD DIAMETERS BUILT TO A. S. M. E UNFIRED PRESSURE VESSEL REQUIREMENTS

A. S. M. E. CODE TANKS—PAR. U69

	Outside Diameter	75 Lbs. W. P.			100 Lbs. W. P.			150 Lbs. W. P.		
		Shell	Heads		Shell	Heads		Shell	Heads	
			Blank	Man-hole		Blank	Man-hole		Blank	Man-hole
↑ Double Butt Weld Construction ↓	36″	.153″	.205″	.330″	.203″	.273″	.398″	.302″	.409″	.534″
	42″	.178″	.239″	.364″	.236″	.319″	.444″	.352″	.478″	.603″
	48″	.203″	.273″	.398″	.270″	.364″	.489″	.403″	.546″	.671″
	60″	.254″	.341″	.466″	.338″	.455″	.580″	.503″	.682″	.807″
	72″	.305″	.409″	.534″	.405″	.546″	.671″	.604″	.750″	.875″
	84″	.355″	.444″	.569″	.472″	.591″	.716″	.704″	.887″	1.02″
	96″	.406″	.512″	.637″	.540″	.682″	.807″	.805″	1.02″	1.18″

A. S. M. E. CODE TANKS—PAR. U70

	Diameter	75 Lbs. W. P.			100 Lbs. W. P.			150 Lbs. W. P.		
		Shell	Heads		Shell	Heads		Shell	Heads	
			Blank	Man-hole		Blank	Man-hole		Blank	Man-hole
↑ Inside Diameter Lap Weld Inside and Outside ↓	36″	.242″	.205″	.330″	.258″	.273″	.398″	.332″	.409″	.534″
	42″	.250″	.239″	.364″	.300″	.319″	.444″	.387″	.478″	.603″
	48″	.258″	.273″	.398″	.343″	.364″	.489″	.442″	.546″	.671″
	60″	.322″	.341″	.466″	.371″	.455″	.580″	.553″	.682″	.807″
↑ Outside Diameter Double Butt Weld Construction ↓	72″	.335″	.409″	.534″	.445″	.546″	.671″	.663″	.750″	.875″
	84″	.391″	.444″	.569″	.519″	.591″	.716″	.774″	.887″	1.02″
	96″	.446″	.512″	.637″	.593″	.682″	.807″	.884″	1.02″	1.18″

LIQUEFIED PETROLEUM GAS TANKS FOR PROPANE STORAGE

L. I. W. STANDARD TANKS FOR STORAGE OF LIQUEFIED PETROLEUM GASES WITH VAPOR PRESSURE NOT TO EXCEED 200 LBS. PER SQ. IN. AT 100° F.

	Water Capacity Gallons	Maximum Gas Capacity Gallons	Outside Diameter	Length Overall	Length on Straight Shell	Thickness Shell	Thickness Heads	Weight of Water	Weight of Gas
	1,200	1,000	3′-6″	18′-0 1/2″	16′-3 1/4″	15/32″	3/8″	10,000	4,250
	2,400	2,000	4′-0″	27′-5 1/4″	25′-5″	9/16″	7/16″	20,000	8,500
	3,200	2,600	5′-1 1/8″	22′-10″	20′-3 7/8″	11/16″	9/16″	26,666	11,050
	4,850	4,040	5′-1 1/8″	35′-4 7/8″	32′-10 3/4″	11/16″	9/16″	40,400	17,170
A.S.T.M.	7,250	6,040	6′-0″	36′-11 3/8″	33′-10 7/8″	13/16″	21/32″	60,400	25,670
A 70	11,500	9,500	7′-0″	42′-11 3/4″	39′-5″	13/16″	3/4″	95,833	40,375
Steel	15,000	12,500	7′-0″	55′-8 3/4″	52′-2″	15/16″	3/4″	125,000	53,125
	18,000	15,000	8′-1 3/4″	50′-5 1/4″	46′-3 1/2″	1 3/32″	7/8″	149,940	63,574
	21,500	18,000	8′-1 3/4″	59′-10 1/4″	55′-8 1/2″	1 3/32″	7/8″	179,160	76,500
	25,000	20,830	8′-1 3/4″	68′-8 3/4″	64′-7″	1 3/32″	7/8″	208,300	88,525
	30,000	25,000	8′-1 3/4″	82′-0 1/2″	77′-10 3/4″	1 3/32″	7/8″	250,000	106,250

L. I. W. STANDARD TANKS FOR STORAGE OF LIQUEFIED PETROLEUM GASES WITH VAPOR PRESSURE NOT TO EXCEED 200 LBS. PER SQ. IN. AT 100° F.

	Water Capacity Gallons	Maximum Gas Capacity Gallons	Outside Diameter	Length Overall	Length on Straight Shell	Thickness Shell	Thickness Heads	Weight of Water	Weight of Gas
	1,200	1,000	3′-6″	18′-0 1/2″	16′-3 1/4″	3/8″	5/16″	10,000	4,250
	2,400	2,000	4′-0″	27′-5 1/8″	25′-5″	7/16″	11/32″	20,000	8,500
	3,200	2,600	5′-0 7/8″	22′-9 7/8″	20′-3 7/8″	17/32″	7/16″	26,666	11,050
	4,850	4,040	5′-0 7/8″	35′-4 3/4″	32′-10 3/4″	17/32″	7/16″	40,400	17,170
A.S.T.M.	7,250	6,040	6′-0″	36′-11 1/8″	33′-10 7/8″	21/32″	17/32″	60,400	25,670
A 149	11,500	9,500	7′-0″	42′-11 1/2″	39′-5″	3/4″	19/32″	97,833	40,375
Steel	15,000	12,500	7′-0″	55′-8 1/4″	52′-2″	3/4″	19/32″	125,000	53,125
	18,000	15,000	8′-1 3/8″	50′-5″	46′-3 1/2″	7/8′	11/16″	149,940	63,574
	21,500	18,000	8′-1 3/8″	59′-10″	55′-8 1/2″	7/8″	11/16″	179,160	76,500
	25,000	20,830	8′-1 3/8″	68′-8 1/4″	64′-7″	7/8″	11/16″	208,300	88,525
	30,000	25,000	8′-1 3/8″	82′-0 1/4″	77′-10 3/4″	7/8″	11/16″	250,000	106,250

LIQUEFIED PETROLEUM GAS TANKS FOR BUTANE AND PROPANE

L. I. W. STANDARD TANKS FOR STORAGE OF LIQUEFIED PETROLEUM GASES WITH VAPOR PRESSURE NOT TO EXCEED 80 LBS. PER SQ. IN. AT 100° F.

	Water Capacity Gallons	Maximum Gas Capacity Gallons	Outside Diameter	Length Overall	Length on Straight Shell	Thickness Shell	Thickness Heads	Weight of Water	Weight of Gas
	6,000	5,280	5′-6″	36′-0 5/8″	34′-0″	5/16″	13/32″	50,000	25,608
	8,000	7,040	6′-0″	40′-4 3/4″	38′-2″	11/32″	7/16″	66,666	34,144
A.S.T.M.	10,000	8,800	6′-6″	42′-11 3/4″	40′-7″	3/8″	7/16″	83,330	42,680
A 70	12,000	10,560	7′-0″	44′-5 1/4″	41′-11″	13/32″	1/2″	100,000	51,216
Steel	15,000	13,200	8′-0″	43′-0 1/8″	40′-0″	7/16″	9/16″	125,000	64,020
	18,000	15,840	8′-0″	51′-2 1/8″	48′-2″	7/16″	9/16″	150,000	76,824
	20,000	17,600	8′-0″	56′-8 1/8″	53′-8″	7/16″	9/16″	166,600	85,360
	25,000	22,000	8′-6″	62′-8″	59′-5″	15/32″	19/32″	208,300	106,700
	30,000	26,400	9′-0″	67′-2″	63′-8″	1/2″	5/8″	250,000	128,040

L. I. W. STANDARD TANKS FOR STORAGE OF LIQUEFIED PETROLEUM GASES WITH VAPOR PRESSURE NOT TO EXCEED 125 LBS. PER SQ. IN. AT 100° F.

	Water Capacity Gallons	Maximum Gas Capacity Gallons	Outside Diameter	Length Overall	Length on Straight Shell	Thickness Shell	Thickness Heads	Weight of Water	Weight of Gas
	6,000	5,225	5′-6″	36′-0 5/8″	34′-0″	15/32″	19/32″	50,000	24,795
	8,000	6,950	6′-0″	40′-4 3/4″	38′-2″	17/32″	5/8″	66,666	33,060
A.S.T.M.	10,000	8,700	6′-6″	42′-11 3/4″	40′-7″	9/16″	11/16″	83,330	41,325
A 70	12,000	10,450	7′-0″	44′-5 1/4″	41′-11″	19/32″	3/4″	100,000	49,637
Steel	15,000	13,050	8′-0″	43′-0 1/8″	40′-0″	11/16″	7/8″	125,000	61,986
	18,000	15,650	8′-0″	51′-2 1/8″	48′-2″	11/16″	7/8″	150,000	74,340
	20,000	17,400	8′-0″	56′-8 1/8″	53′-8″	11/16″	7/8″	166,600	82,650
	25,000	21,700	8′-6″	62′-8″	59′-5″	23/32″	7/8″	208,300	103,312
	30,000	26,100	9′-0″	67′-2″	63′-8″	25/32″	15/16″	250,000	124,000

Propane Storage Tank 8′-2¼″ Diameter x 50′-5¼″ Long for 200 Pounds Working Pressure

LIQUEFIED PETROLEUM GAS

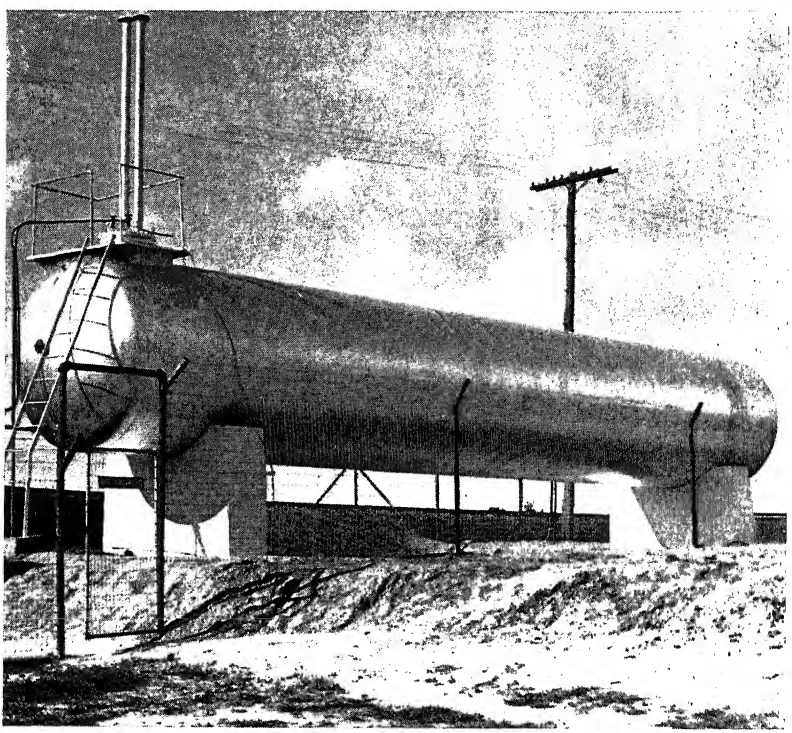
Originally all liquefied petroleum gases were made from natural gas. They are still obtained from this source, but natural gas now does not furnish the only source of these materials. Oil refineries are manufacturing butanes and propane in increasing quantities from refinery vapors, by separation of the hydrocarbons in the vapors.

Each year there is an increasing list of uses for these gases in commercial lines, in addition to the ever-increasing list of domestic users.

Commercial propane and butanes are gases at ordinary pressures and temperatures, and in order that containers or tanks for these fuels may be of economical size, they must be stored under such a pressure that they are in liquid form.

The important and useful characteristic of these gases is that they are inflammable, and it is therefore necessary to use proper precautions against fire in the handling and storing of these fuels.

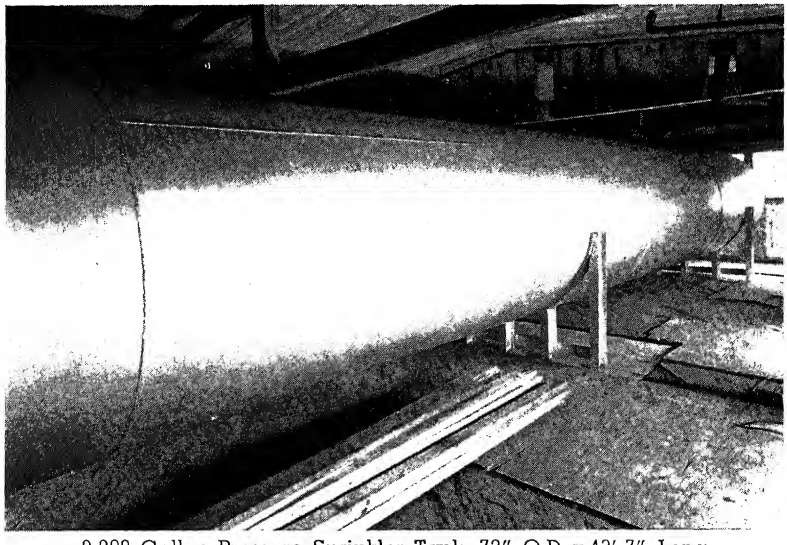
Tanks must be properly designed and carefully constructed for these gases. Long and successful experience by Lancaster Iron Works guarantees sturdy, well-made, high-class tanks, built as carefully and as safely as best modern manufacturing methods permit.



15,000 Gallon Propane Capacity Liquefied Petroleum Gas Storage Tank

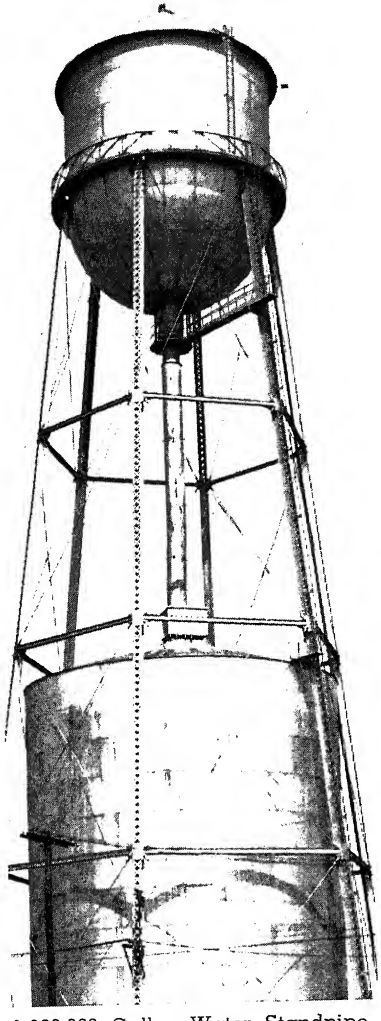
L. I. W. STANDARD—N. F. P. A. SPECIFICATION PRESSURE TANKS FOR SPRINKLER SYSTEMS

Capacity in Gallons	Outside Diameter	Capacity Shell Length	Approx. Overall Length	Capacity in Gallons	Outside Diameter	Capacity Shell Length	Approx. Overall Length
1500	3′-0″	29′-2½″	30′-3″	5000	6′-0″	24′-2¾″	26′-4″
1500	4′-0″	16′-4½″	17′-10″	5000	7′-0″	17′-9½″	20′-3″
1500	5′-0″	10′-5¾″	12′-3″	5000	8′-0″	13′-7½″	16′-5″
2000	4′-0″	21′-10″	23′-3″	6000	6′-0″	29′-0¾″	31′-2″
2000	5′-0″	13′-11½″	15′-9″	6000	7′-0″	21′-4″	23′-10″
2000	6′-0″	9′-8¼″	11′-10″	6000	8′-0″	16′-4″	19′-2″
2500	4′-0″	27′-3¼″	28′-8″	7000	6′-0″	33′-10¾″	36′-0″
2500	5′-0″	17′-5¼″	19′-2″	7000	7′-0″	24′-10½″	27′-4″
2500	6′-0″	12′-1½″	14′-3″	7500	6′-0″	36′-4″	38′-5″
3000	4′-0″	32′-8¾″	34′-2″	7500	7′-0″	26′-7¾″	29′-1″
3000	5′-0″	20′-11¼″	22′-8″	7500	8′-0″	20′-5″	23′-3″
3000	6′-0″	14′-6½″	16′-8″	8000	7′-0″	28′-5¼″	30′-11″
4000	5′-0″	27′-10¾″	29′-8″	8000	7′-6″	23′-2½″	25′-10″
4000	6′-0″	19′-4½″	21′-6″	8000	8′-0″	20′-5″	23′-2″
4500	6′-0″	21′-9½″	23′-11″	9000	7′-0″	32′-0″	34′-6″
4500	7′-0″	16′-0″	18′-6″	9000	8′-0″	24′-6″	27′-4″
4500	7′-6″	13′-11½″	15′-9″	9000	9′-0″	19′-4¼″	22′-6″



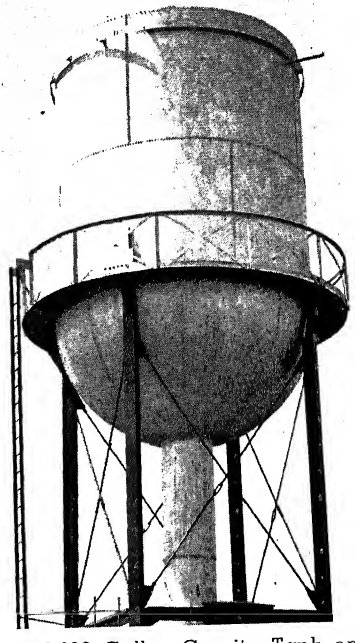
9,000 Gallon Pressure Sprinkler Tank, 72″ O.D. x 43′-7″ Long
Erected in Building

ELEVATED STEEL TANKS



1,000,000 Gallon Water Standpipe
70 Feet High and 250,000 Gallon
Sprinkler Tank 200 Feet High

LANCASTER Elevated Tanks are built in a complete range of standard sizes for industrial, municipal or private water systems. These tanks provide gravity water pressure for fire protection or general service.



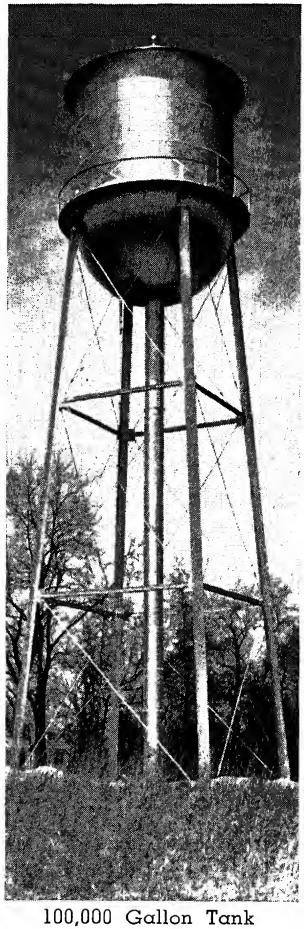
30,000 Gallon Gravity Tank on
Roof of Building

ELEVATED STEEL TANKS

L. I. W. STANDARD HEMISPHERICAL BOTTOM ELEVATED TANKS

Standard Tank equipment includes Cone Roof, Steel Balcony with Handrail, Inside and Outside Tank Ladders, Roof Swivel Ladder, Tower Ladder, Riser Pipe, Roof Hatch, Standard Pipe Fittings, Stub Overflow and Base Elbow. Other special fittings, gauges, heater pipes, etc., furnished if desired.

Capacity in U.S. Gallons	Diameter of Tank	Height of Shell	Height of Shell and Bottom	Area For Wind Moment
*5,000	10′-0″	8′-0″	9′-4⅛″	103.5
10,000	12′-0″	8′-0″	14′-0″	173.28
15,000	14′-0″	8′-6″	15′-6″	224.0
20,000	14′-0″	13′-6″	20′-6″	294.0
25,000	16′-0″	12′-0″	20′-0″	329.46
30,000	16′-0″	15′-0″	23′-0″	377.46
35,000	18′-0″	13′-0″	22′-0″	407.96
40,000	18′-0″	15′-9″	24′-9″	457.46
45,000	18′-0″	18′-6″	27′-6″	511.46
50,000	20′-0″	15′-0″	25′-0″	514.74
60,000	20′-0″	19′-6″	29′-6″	604.74
65,000	22′-0″	16′-0″	27′-0″	611.87
70,000	22′-0″	18′-0″	29′-0″	655.87
75,000	24′-0″	15′-0″	27′-0″	669.33
80,000	24′-0″	16′-6″	28′-6″	705.33
90,000	24′-0″	19′-6″	31′-6″	777.33
100,000	25′-0″	20′-0″	32′-6″	835.0
120,000	25′-0″	25′-0″	37′-6″	960.7
125,000	25′-0″	26′-3″	38′-9″	992.0
150,000	28′-0″	24′-0″	38′-0″	1093.07
175,000	28′-0″	29′-6″	43′-6″	1247.07
200,000	30′-0″	28′-6″	43′-6″	1338.33
250,000	32′-0″	32′-0″	48′-0″	1574.47
300,000	34′-0″	34′-0″	51′-0″	1776.86
350,000	36′-0″	35′-0″	53′-0″	1956.08
400,000	38′-0″	36′-0″	55′-0″	2143.41
450,000	40′-0″	36′-0″	56′-0″	2299.24
500,000	42′-0″	36′-0″	57′-0″	2459.33



100,000 Gallon Tank on 100 Ft. Tower

*5000 gal. tanks have dished heads top and bottom.

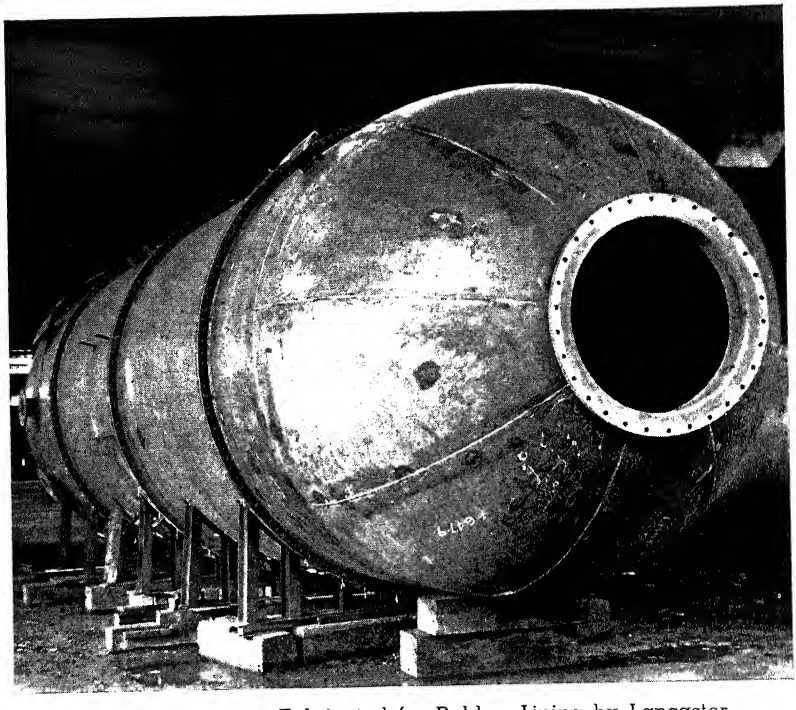
A.P.I—A.S.M.E. CODE

The A. P. I.—A. S. M. E. Code is a pressure vessel code prepared by a joint committee of the A. P. I. and A. S. M. E., specifically to embody the experience of the petroleum industry and to meet its special requirements.

Vessels built under the A. P. I.—A. S. M. E. Code are usually designed for the most severe combination of operating conditions to be experienced in normal operation.

These vessels, which are fusion-welded or riveted, unfired pressure vessels, are constructed for petroleum liquids or gases and for metal temperatures not over 1000° F.

Vessels built under this code are stress relieved only when the ratio of the inside diameter to the cube of the shell thickness at any welded joint or head plate is less than 100, or when these plates are over 1¼" in thickness at any welded joint. Outside these limitations, Lancaster has built and is prepared to furnish miscellaneous pressure vessels built in accordance with the A. P. I.—A. S. M. E. Code, and the careful workmanship employed, coupled with our long experience in Code, and high specification work for refinery use assures you a quality product.



Code Construction Fabricated for Rubber Lining by Lancaster Certified Welders

VULCANIZERS AND DEVULCANIZERS

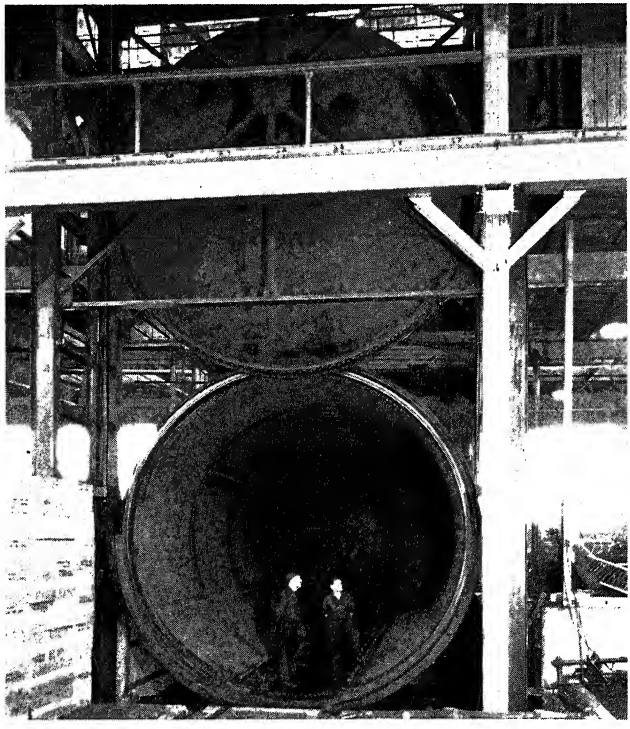
L. I. W. Vulcanizers are representative of the highest type efficiency and workmanship. They can be supplied from 18" diameter laboratory size to the 15 feet diameter Vulcanizer shown in photograph below. Either vertical or horizontal type can be furnished for various pressures to code requirements.

CYLINDERS AND RETORTS

Lancaster also builds dryer shells, creosoting retorts, wolmanizing cylinders and similar equipment, with quick-opening or bolted-type doors for the various process industries.

PAPER MILL EQUIPMENT

Spherical rotary digesters, rotary bleaching boilers, sulphite and sulphate digesters, kiers, storage tanks, bins, etc., are all part of the complete line of plate products fabricated by Lancaster for the paper industry.



15'-3" O.D. x 40' Long Vulcanizer for Large Eastern Rubber Company. "Built by Lancaster"

UNDERWRITER'S LABORATORIES SPECIFICATIONS FOR HORIZONTAL UNDERGROUND STORAGE TANKS

Horizontal tanks shall not exceed the maximum capacities, diameters, or lengths for the corresponding gauges of metal outlined in the following table, except as noted below.

U. S. S. Gauge Metal	Approx. Thickness Inches	Maximum Capacity U. S. Gal.	Maximum Diameter Inches	Maximum Length of Shell Feet
16	1/16	285	38	8
14	5/64	560	46	11
12	7/64	1,100	56	14
7	3/16	4,000*	84*	22*
3	1/4	12,000*	126*	32*
0	5/16	20,000*	132*	42*
000	3/8	30,000*	132*	50*

***To take care of miscalculations and mistakes in fabrication, for tanks made of No. 7 or heavier gauge metal, a tolerance of 10 per cent in capacity and a tolerance of 5 per cent in either the diameter or the length will be permitted. This does not mean that tanks made of No. 7 or heavier gauge stocks should be intentionally designed to have capacities, diameters, or lengths in excess of the nominal maximums designated above for such stocks.**

SPECIAL

Tanks made of 5/16" or 3/8" metal and constructed as required by the Standard may employ diameters up to and including 144". Tanks having diameters of from 133" to 144" shall not be labelled until the manufacturer has obtained advices from the transportation company stating that the tank can be accepted for delivery to the customer.

Tanks up to 30,000 gallons capacity for storing Class III liquids (flash point above 70° F. and below 200° F., closed cup tester) may be made of 1/4" material, if adequate internal bracing is provided.

SHELL SEAMS

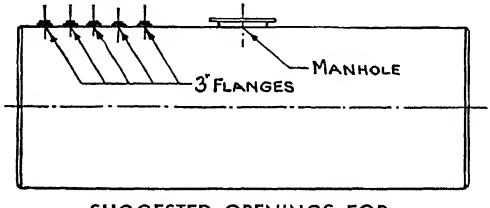
Shell and head seams may be riveted or welded.

HEADS

Flat flanged, braced heads; dished heads, or flanged and dished heads, are permissible, when the proper joints are used, in accordance with requirements.

TESTS

Before painting, tanks shall be tested and proven tight against leakage under a test pressure of not less than 5 nor more than 10 pounds per square inch.



SUGGESTED OPENINGS FOR UNDER-GROUND TANKS

Note—Customer to specify exact size and location of openings required.

UNDERWRITER'S LABORATORIES SPECIFICATIONS FOR HORIZONTAL ABOVEGROUND STORAGE TANKS

CAPACITY

The capacity shall not be less than 2,500 gallons nor greater than 35,000 gallons.

DIMENSIONS

These tanks may be of any diameter from 4 ft. up to 11 ft. inclusive and any length, that can be shipped on a single railroad car. In no case must the diameter be greater than the length, or the length more than six times the diameter.

MATERIAL

Standard open-hearth steel tank plate is to be used in the construction of these tanks. The minimum thickness of metal required for shell and breadth of tanks from 48 to 72 inches in diameter is 3/16" and from 73 to 132 inches in diameter is 1/4".

SHELL SEAMS

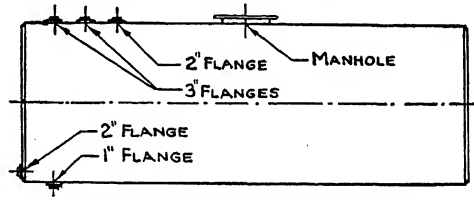
Shell and head seams may be riveted or welded.

HEADS

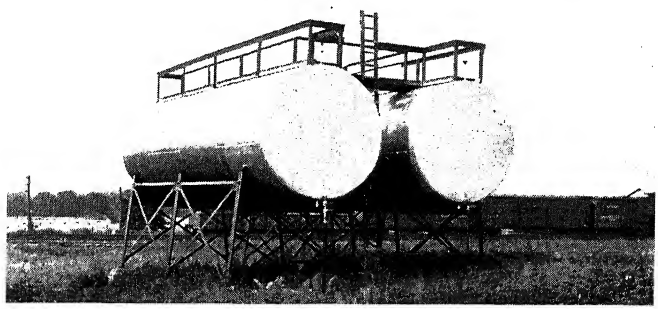
Heads may be in one or two pieces. If made in two pieces, the seam joining the two pieces together must be made in the same manner as the longitudinal seams are made. Flat Flanged braced heads; dished heads, or flanged and dished heads, are permissible, when the proper joints are used in accordance with requirements.

TESTS

Each tank must be tested and proven tight under a pressure of approximately one and one-half times the pressure exerted on the bottom when tank is filled with water.



SUGGESTED OPENINGS FOR ABOVE-GROUND TANKS



Horizontal Storage Tanks on Structural Supports
Furnished any style or height.

UNDERWRITER'S LABORATORIES SPECIFICATIONS FOR VERTICAL ABOVEGROUND STORAGE TANKS

CAPACITY

The tanks shall have a capacity of more than 2,500 gallons and less than 25,000 gallons.

DIMENSIONS

These tanks are cylindrical in shape, the height never being more than four times the diameter. A maximum diameter of 11 feet and a maximum height of 35 feet are permissible.

MATERIAL

Standard sheets of open hearth steel tank plate must be used in the construction of these tanks.

BOTTOM

The bottom of these tanks shall be in one or two pieces and not less than 3/16" thick. They may be riveted or welded to the shell.

SHELL

The shell must be not less than 3/16" thick for tanks up to 25 feet in height. For tanks from 25 to 30 feet high, the first ring must be not less than 1/4" thick and not less than 5 feet wide. The rings above the first must not be less than 3/16" thick.

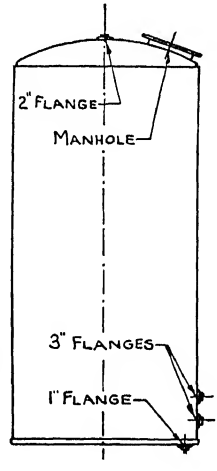
Tanks between 30 and 35 feet high must have first two rings not less than 1/4" thick. Each of these 1/4" rings must be not less than 5 feet wide; the remaining rings must be not less than 3/16" thick. The seams of the shell may be riveted or welded.

TOP

The tops of these must either be dished or cone-shaped and No. 10 U. S. gauge or heavier steel.

TESTS

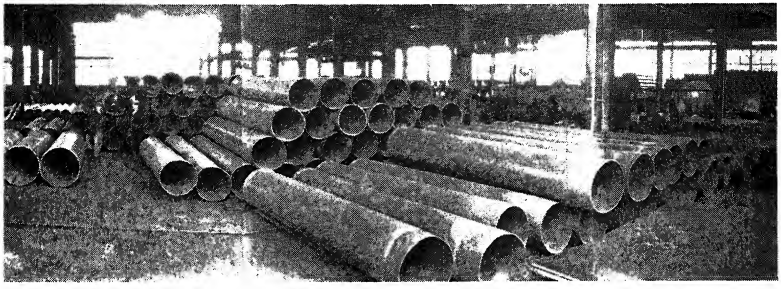
All tanks must be tested and proven tight against leakage under a test pressure of not less than one and one-half times the pressure exerted on the bottom when the tank is full of water, or the tank may be filled with water and 5 pounds air pressure applied to test the top.



SUGGESTED OPENINGS FOR VERTICAL TANKS

Customer to specify exact size and location of openings required.

DREDGE PIPE



Welded or Riveted Shore and Pontoon Pipe

Lancaster Dredge Pipe is known throughout the United States, wherever suction dredge work is being carried on.

We have been pioneers in the design and development of modern dredge pipe and have over forty years' experience in designing and building Pipe Lines and Accessories for Hydraulic Dredges.

All U. S. Government Engineer Offices and the majority of civilian dredges 8" dia. capacity and over use Lancaster Pipe. This pipe is designed and fabricated to insure lower cost per yard delivered at the end of the pipe line than any other pipe manufactured.

Any style pipe can be supplied 8" dia. and upwards, made of our Special Analysis Pipe Steel containing a high percentage of carbon and manganese.

Shore Pipe constructed with our special Posey Joints fits easily and will last longer.

PONTOON CYLINDERS—CATAMARANS
GATE VALVES—Y-BRANCHES
COMBINATION "Y-VALVES"
STEEL BARGES AND DREDGE HULLS

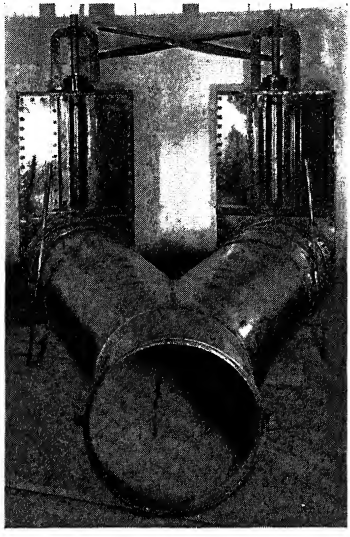
STEEL SPUDS

Specially-designed steel Spuds to replace combination wood and steel units are built by us for all prominent dredgers.

Spuds are fabricated in laminated sections of extreme strength, fitted together by special machinery and spot welded. These Spuds have been used for many years with universal satisfaction.

Let us design and build Spuds for your requirements.

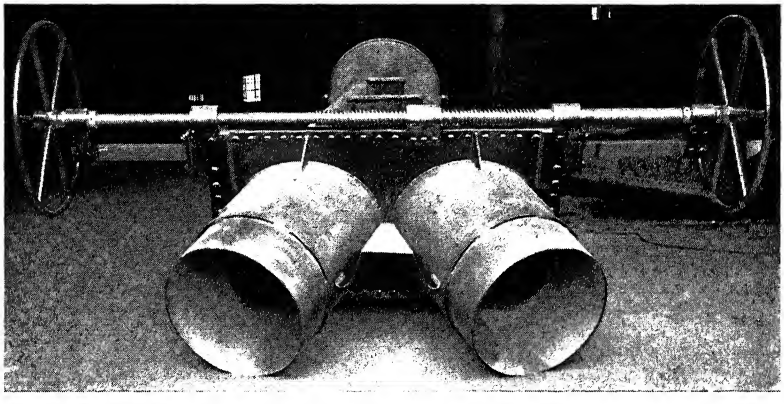
COMBINATION Y BRANCH AND GATE VALVES



LANCASTER STANDARD LEVER TYPE VALVE

This Valve which has been in successful use for many years is furnished in diameters 16" to 30".

Note special reinforced crotch, insuring long service. This is a standard type combination Valve used by most dredges and is recommended for pressures up to 100 pounds as shown. For heavier pressures, we make these Valves with specially reinforced bonnets.



ERICKSON TYPE PATENTED RECIPROCATING GATE VALVE

This Valve is built in diameters 16" to 30" and for working pressures to 150 pounds per square inch. A special feature of this Valve is that, being only a few inches higher than the pipe, the Shore Pipe can be rolled over the Valve by laying a light timber on the screw. This is of considerable advantage when lines are laid over marshes.

HULLS FOR GOLD DREDGES

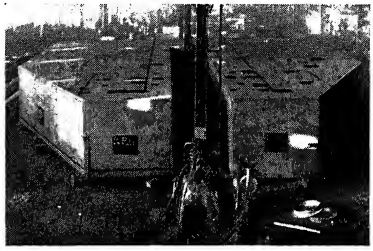
LANCASTER Steel Hulls for use in Gold, Tin and Platinum dredging are known and in operation in all parts of the world.

These hulls are part of the equipment used in placer dredging and require an exactness of manufacture and perfection of shop assembly before knocking down for erection in foreign fields.

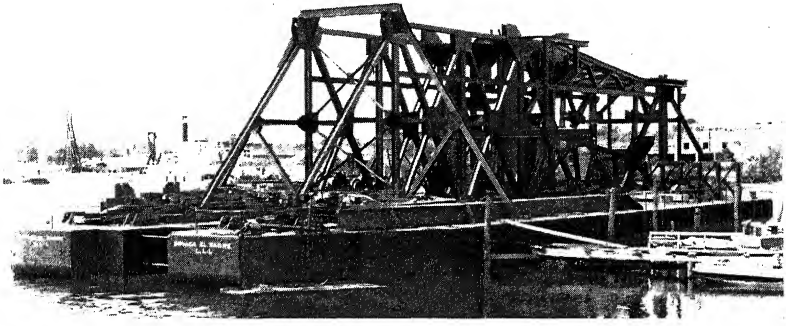
Many of the dredging fields are virtually inaccessible, requiring parts of limited size to be transported by airplane from nearest seaport.

Whenever feasible, Hull and Superstructure are completely assembled, ready to attach tugs for towing to destination.

Efficient production with long experience in this line enables LANCASTER to produce these important dredging units to the entire satisfaction of dredgers in many lands.

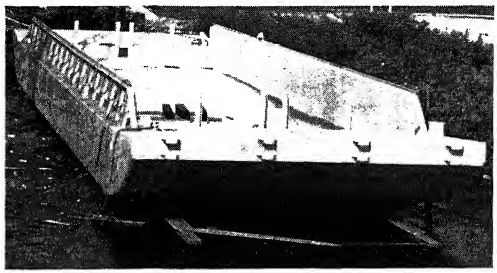


Hulls under Construction and Complete Assembly in Our Lancaster Shops



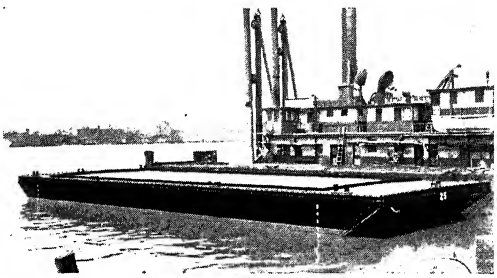
Steel Hull 66′ x 165′ x 11′ with Superstructure, Erected by L. I. W. in Tampa, Florida, then Towed to Colombia, South America

BARGES AND SCOWS

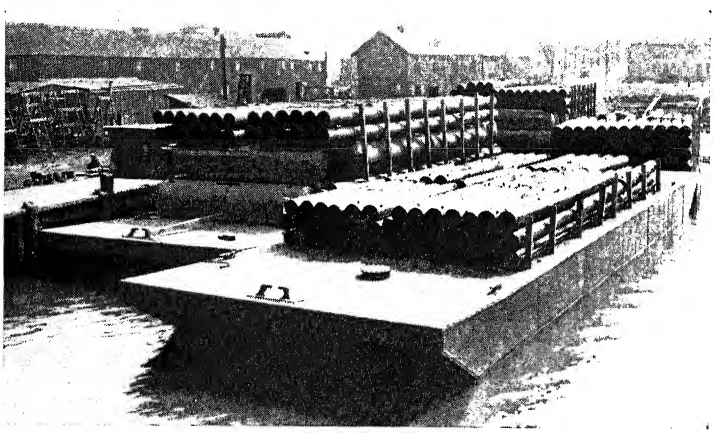


River and Harbor
Floating Equipment
of Steel Construction

Barges, Hulls, Scows
for
Gasoline, Fuel Oil,
Water, Molasses,
Vegetable Oils, etc.
Landing Flats
Car Floats



We design and build inland waterway barges in our own shops and then erect and launch at any port.



Part of a fleet of all-steel Barges 25' x 85' x 7', designed and fabricated in our shops and erected and launched in our yards along the Chesapeake Bay. These Barges were towed to Miami, Florida, loaded with Lancaster Dredge Pipe and Pontoons.

STACKS

Our long experience in the design and manufacture of Stacks of all kinds, enables us to properly fabricate and erect any type or size, either self-supporting or guyed construction.

When sending inquiries for Stacks, all the information possible to secure should be furnished, such as horsepower of boilers, flue sizes or openings in boilers, height and style of foundation, wind loads if unusual and all local information available.

Our Engineering Department is at your disposal.

GUYED STEEL STACKS

RECOMMENDED THICKNESSES:

Diameter	Maximum	Minimum
30″	No. 8 Ga.	No. 10 Ga.
36″	3/16″	No. 10 Ga.
42″	1/4″	No. 10 Ga.
48″	1/4″	No. 8 Ga.
54″	5/16″	3/16″
60″	5/16″	3/16″

1/16″ is often added to above thicknesses for corrosion.

GUYS:

Stacks up to 60′ or 70′ high, usually require
1—set 4-way guys.
Stacks over 70′ high, usually require
2—sets 4-way guys.
Stacks over 125′ high, usually require
3—sets 4-way guys.

A single set of guys is usually attached to stack about 1/3 way down from top. When 2 sets of guys are used, it is usual practice to locate first set about 2/3 height of stack and the second set about 1/9 height of stack. When 3 sets of guys are used, the first set is placed at H — 12 ft. and the second set at 3/4 H — 12 ft. and the third set at 1/2 H — 12 ft. In this case H is the height in feet of Stack.

SELF-SUPPORTING STEEL STACKS

Diameter of Cone Bottom usually 1/3 larger in diameter than straight stack section.

Height of Cone should be approximately 1/1 entire height of Stack.

The Conical Section of a well-designed Self-Supporting Stack should be made so that the apex of the cone would be at the top of the Stack.

Consult us for proper design of any size or type smokestacks.

STACKS

The design of smokestacks is often influenced by local conditions to such an extent that it is advisable to change certain constants to cope with existing conditions. Therefore we recommend that customers give us complete information on conditions and then permit us to submit our recommended design for the stack or stacks to be erected. Lack of space prohibits listing of the many design formulas used in this fiield, but for general use we give several condensed formulas acceptable for quick use in determining stresses, material thickness, also foundation bolts required for stacks.

STRESS PER LINEAL INCH ON CIRCUMFERENCE ON STRAIGHT STACKS

For 25 lbs. Wind Pressure (normal)

$$S = \frac{1.33 \times H^2}{d}$$

P = Wind Pressure in pounds per square foot.
H = Distance in feet of any point below the top of the Stack.
d = Diameter of the Stack in feet.
S = Stress per lineal inch on circumference.

STRESS PER LINEAL INCH ON CIRCUMFERENCE OF BELL BOTTOM STACKS

D = Diameter of Bell in inches.

For 25 lbs. Wind Pressure (normal)

$$S = \frac{1.33 \times H^2 \times d}{D^2}$$

THICKNESS OF STEEL PLATES

S = Allowable Stress in net section.
e = Efficiency of joint.

For 25 lbs. Wind Pressure (normal)

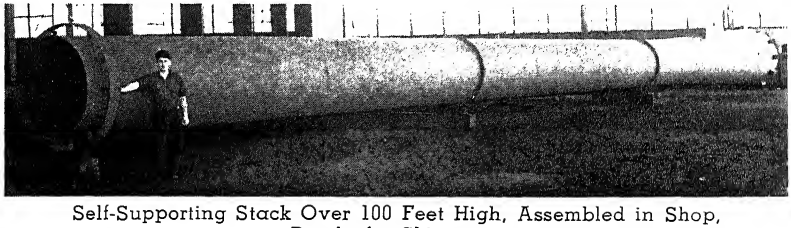
$$t = \frac{1.33 \times H^2}{d \times S \times e}$$

FOUNDATION BOLTS FOR STACKS OR STANDPIPES

S = Total Stress in one Anchor Bolt in pounds.
G = Circumferential spacing of Bolts in inches.
D = Diameter of Column in feet.
B = Diameter of Bolt Circle in feet.
H = Height of Column in feet.
W = Weight of Column in pounds.

$$S = \frac{1.33 \times GH^2 \times D}{B^2} = \frac{GW}{37.7 \times D}$$

Note—Bolts in tension usually figured at 15,000 pounds per square inch allowable unit stress on net section at root of threads.



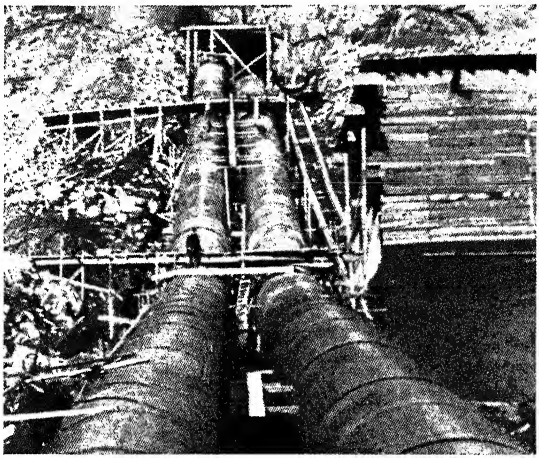
Self-Supporting Stack Over 100 Feet High, Assembled in Shop, Ready for Shipment

LANCASTER STANDARD PIPE

Steel or Wrought Iron Pipe made by Lancaster is furnished to many industries and for many purposes. Diameters from 10 inches upwards are made in all lengths, of welded or riveted construction and with plain, flanged or special ends. Pipe coated to specifications.

Offsets, elbows or special shapes of any style are fabricated to suit unusual requirements. Pipe furnished for

Water lines, Conduits, Penstocks, Scroll Casings
Air and Gas lines, Sludge lines, Steam lines
Ocean Outfall lines, Oil, Exhaust Steam, Chemicals, etc.



9′-0″ Diameter Penstocks 700 Ft. Long

CAISSONS — FORMS — TUNNEL LINING

Manufacturing experience of many years, coupled with thorough knowledge of customer requirements, enables us to turn out welded or riveted Pipe and Casing of all kinds to the most exacting requirements.

STEEL BINS

Bins can be divided into three general classes:

1. DRY 2. SEMI-LIQUID 3. LIQUID

Examples of materials stored in the three classes of BINS are:

1. DRY

Ashes — Barley — Carbon Black — Cinders — Coal — Coal Dust — Briquettes — Coke — Crushed Stone — Dry Cement — Fertilizer — Fuller's Earth — Grain — Gravel — Lime — Malt — Ores — Quartz — Salt — Sand — Seeds — Soda Ash — Starch — Sugar.

2. SEMI-LIQUID

Asphalt — Beet Sugar Syrup — Blackstrap Molasses — Fats (Animal) — Fats (Soap Stock) — Glycerine — Graphite — Grease — Lard — Mash — Paraffin — Soap — Tallow — Tar — White Lead.

3. LIQUID

Acids — Ammonia — Alcohol — Chemicals — Dyes — Ink — Oils — Paints — Soap Liquids — Syrups — Turpentine — Varnish — Vinegar — Water.

BINS are constructed with straight, sloping or curved sides. They may be built with flat bottoms, resting directly upon foundations, or with suspended bottoms of conical, hemispherical or other style, or the BINS may be entirely of suspension type, with sloping or parabolic sides, as often used in coal bunkers and hoppers.

BINS with suspended bottoms are usually of open top construction and, if so, should be designed for possible or probable surcharge. The saving in steel by taking advantage of the tensile strength of the plates and thus avoiding supporting beams is considerable. In comparison to concrete Bins, the Steel Bin is able to withstand "breathing" of BINS from vertical loads without cracking, naturally a great advantage. The coefficient of friction is far less in smooth steel BINS with welded seams than in Masonry Bins.

BINS are frequently built of a shape and size to fit existing conditions, without much regard to proper design. We can submit proposal and recommendations covering BINS for various purposes if we are furnished with information covering:

Nature of material to be stored.

Quantity of material to be stored or total volume desired.

Preferred shape of Bin and style of bottom.

Available space for Bin and erection data if necessary.

STEEL BINS

It will readily be recognized that there is a vast difference in weights of materials to be stored in BINS, as for example, the average weight of dry Sand is 100 pounds per cubic foot, with Rye weighing just one-half as much and loose Flour about one-third that of Sand.

The destructive action of materials in metal BINS can be classified into CORROSIVES and EROSIVES. Corrosives are substances such as Acids or Chemical Agents that dissolve or disintegrate metal surfaces. Erosives are abrasive substances such as sharp Sand, Ore or Gravel that will wear away metal surfaces by constant rubbing or abrasion.

Therefore it will be seen that BINS should not only be designed to resist physical stresses set up by weight of contents, but should sometimes have extra thickness of material added to take care of abrasion, or should be constructed of special Metals or Alloys to combat erosive action. To avoid increasing thickness of ordinary Steel plates, special Abrasive Resisting Steels are available for BIN manufacture, and such Steels add years of life to BINS subject to abrasive action of contents. These Steels contain higher percentages of Manganese and Carbon, and the slight extra cost is compensated by greatly increased life of Steel Bins.

BINS are sometimes furnished with special Linings of Metal, Rubber or Composition, particularly when used with Acids or destructive Chemicals, and in such cases, while we will be glad to make suggestions or assist in design, we cannot guarantee any definite resistance of life of BINS or Linings and prefer to have customers furnish their own specifications.

CAPACITIES OF SUSPENDED BIN BOTTOMS

For quick estimates on capacities of BIN bottoms of hopper or suspended type, the following simplified formulas are useful:

HEMISPHERICAL BOTTOMS

Radius^3 x 2.0944 = Cubic feet capacity.

CONICAL BOTTOMS

Diameter^2 x Height x .2618 = Cubic feet capacity.

PYRAMID BOTTOMS

⅓ Height x Area of Base = Cubic feet capacity.

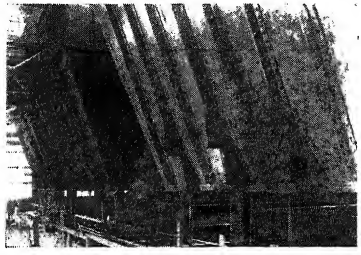
NOTE

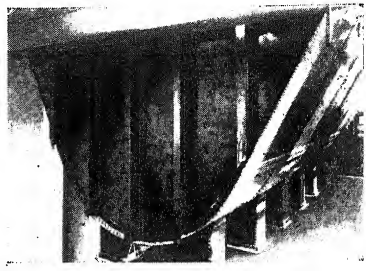
One Cubic Foot contains 7.48 gallons.

BUNKERS, HOPPERS AND BINS

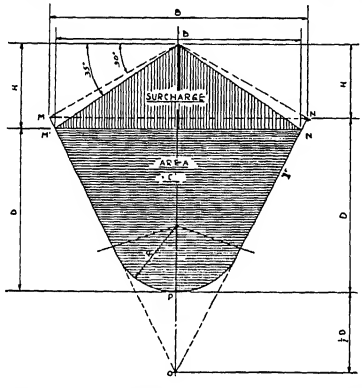
Many types of Suspended Bunkers or Bins of all kinds are used wherever various materials are stored or handled.

It is only necessary to indicate to us your general storage requirements, space needed and working conditions. Our Engineers cooperate with you in designing such structures. We will fabricate and erect anywhere and under all conditions.





CAPACITIES OF SUSPENSION BINS



The Suspension Bunker, designed with a cross-section such that tension is the only stress produced in the envelope, is a very economical type, since stiffeners are required only on end or interior bulk-heads and on the girders which support the bag bottom.

For any given values of width B, and depth D, regardless of the weight of contained material or the ratio of B to D, a very close approximation of the correct tension curve is given by the construction shown in the accompanying diagram. Locate "O" on the center-line of the bunker at a distance 1½D below the top, MN. Draw the lines MO and NO. Locate P on the center-line at the desired depth, D. Draw a circular arc tangent to MO and NO, and passing through P. The outline MPN is close enough to the ideal tension-curve for detailed design as well as for estimating.

The capacity below the line MN, in cubic feet per foot of length is

$$C = \tfrac{5}{8}BD$$

Capacity per foot of length in tons of coal at 50 pounds per cubic foot is

$$T = \frac{BD}{64}$$

For bunkers carrying a surcharge, use 30° slopes from M and N to determine maximum loading height "H" so as to prevent over-flow, and use 35° slopes from the peak so located, to calculate storage capacity, which will be

$C' = \tfrac{5}{8}B'D' +$ surcharge volume, or $T' = \dfrac{B'D'}{64} +$ surcharge tonnage.

In figuring the surcharge, loss due to end slopes and to cross-valleys between load points must be considered.

A. S. M. E. CODE—UNFIRED PRESSURE VESSELS — WELDED CONSTRUCTION

Class	Maximum Plate Thickness Permissible	Maximum Allowable Working Pressure	Uses	Style of Joints		Joint Efficiency Permissible	Construction Tests	Inspection Test Requirements	Stress Relieving
				Circumferential	Longitudinal				
Par. U68	Not Limited	Not Limited	For any purpose	Double Welded Butts	Double Welded Butts	90%	Test plates required for continuation and duplication of weld in longitudinal joint. Tension and bend test specimen plates required. All welded joints shall be radiographed.	All vessels shall be tested under hydrostatic pressure of not less than 1½ times the maximum allowable working pressure and while under this pressure, the joints shall be given a hammer or impact test. Following this test, the pressure shall be raised to not less than twice the allowable working pressure and maintained during inspection.	Required without Exception
Par. U69	1½"	400#	For any purpose, with the following exceptions:— 1. Not for lethal gases or liquids. 2. Not for liquids operating at a temperature in excess of 300° F. unless vessel is over 1½" thick. 3. Not for maximum pressure over 400#. 4. Not for temperatures in excess of 700° F.	Double Welded Butts—except for 5/16" and less, which may be Single Butt Type Joints	Double Welded Butts	80%	Manufacturer to conduct tests of welding process also of welding operators. Tests of welding operators are effective for a period of 6 months, or 1 year if operator is continually engaged on same process and type of welding.	Same as Par. U68	Required only when thickness exceeds 1½" or where both the wall thickness is greater than 0.58" and the shell diameter is less than 20" or where the diameter in inches is less than 120 t—50, where t is the thickness in inches.
Par. U70	5/16"	200#	For storage of gases or liquids, with the following exceptions:— 1. Not for lethal gases or liquids. 2. Not for temperatures materially exceeding the boiling temperatures at atmospheric pressure. 3. Not for maximum pressure over 200#. 4. Not for temperatures in excess of 200° F.	May be Butt or Lap Type Joints	Double Welded Butts for 5/16" or less, or Double Welded Laps for 3/8" or less, or Single Welded Laps for 1/4" or less	Variable. Use stresses in Table.	Same as Par. U69	Same as Par. U68	Not Required

NOTE—The above information is extracted from Rules for Construction of Unfired Pressure Vessels. Section VIII A. S. M. E. Boiler Construction Code. 1937 edition. For complete information see latest edition A. S. M. E. Boiler Construction Code.

TABLE SHOWING VALUES USED IN CODE PRESSURE VESSELS ABOVE WHICH PIPE NOZZLES MUST BE REINFORCED

DIAMETER OF NOZZLE

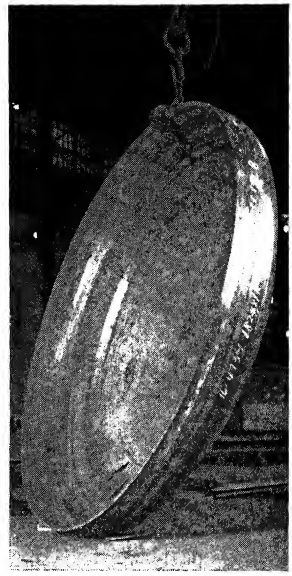
Thickness of Shell	2″	2½″	3″	3½″	4″	5″	6″	8″	10″	12″	14″	16″	18″	20″	24″
3/16″	4,565	4,334	3,609	3,272	3,045	2,736	2,554	2,294	2,147	2,100	1,943	1,904	1,874	1,851	1,816
	5,510	5,402	4,394	3,927	3,615	3,186	2,934	2,602	2,356	2,295	2,058	2,004	1,962	1,930	1,885
1/4″	5,630	5,426	4,655	4,298	4,234	3,695	3,460	3,098	2,893	2,825	2,665	2,603	2,556	2,518	2,463
	6,575	6,616	5,610	5,148	5,019	4,365	4,020	3,485	3,201	3,109	2,869	2,780	2,712	2,658	2,578
5/16″	6,696	6,350	5,471	5,064	4,966	4,443	4,246	3,807	3,571	3,562	3,424	3,334	3,266	3,211	3,131
	7,641	7,540	6,426	5,914	5,751	5,143	4,906	4,267	3,931	3,948	3,754	3,622	3,518	3,437	3,217
3/8″	7,762	7,274	6,287	5,830	5,698	5,129	4,905	4,435	4,181	4,202	4,220	4,098	4,004	3,930	3,820
	8,707	8,464	7,242	6,680	6,483	5,829	5,565	4,895	4,541	4,619	4,680	4,498	4,356	4,245	4,080
7/16″	8,827	8,198	7,103	6,596	6,430	5,815	5,564	5,063	4,791	4,802	5,053	4,843	4,770	4,675	4,530
	9,772	9,388	8,058	7,446	7,215	6,515	6,224	5,523	5,151	5,219	5,678	5,385	5,250	5,103	4,884
1/2″	9,893	9,122	7,919	7,362	7,162	6,501	6,223	5,691	5,401	5,402	5,923	5,740	5,564	5,446	5,261
	10,138	10,312	8,874	8,212	7,947	7,201	6,883	6,151	5,761	5,819	6,708	6,420	6,164	5,983	5,704
9/16″	10,958	10,046	8,735	8,128	7,894	7,187	6,882	6,319	6,011	6,002	6,830	6,579	6,386	6,243	6,013
	11,903	11,236	9,690	8,978	8,679	7,887	7,542	6,779	6,371	6,419	7,866	7,479	7,176	6,953	6,598
5/8″	12,024	10,970	9,551	8,844	8,626	7,873	7,541	6,947	6,621	6,602	7,774	7,470	7,236	7,092	6,786
	12,969	12,160	10,506	9,744	9,411	8,573	8,201	7,407	6,981	7,019	9,054	8,580	8,216	7,967	7,509

Table showing limiting values of P x D above which nozzles must be reinforced.
The upper value pertains to nozzles with the neck flush inside and welded outside only.
The lower value pertains to nozzles with the neck extending inside and welded inside and outside.
The neck of nozzles up to 12″ inclusive are figured as standard pipe.
The neck of those above 12″ is figured as being equal to the thickness of the plate to which it is welded.
These values are based on an E of .80 and may be adjusted for any efficiency by multiplying by the factor E/.80.

STANDARD FLANGED AND DISHED HEADS

Heads usually formed from Hot or Cold Pressing Steel, Cold Flanging Steel, Drawing Quality Steel, Firebox, Marine or Stillbottom Steel. If required, Heads can be furnished from Special Steels or Alloy Metals.

O.D.	S.R.	T	S	r
Outside Diam.	Radius of Dish	Gauge Min. Max.	Straight Flange	Inside Corner Radius
18″	18″	3/16″-3/4″	2″-3″	1/2″-1″
24″	24″	3/16″-1″	2″-5″	1/2″-2″
30″	30″	3/16″-1 1/8″	2″-5 1/2″	1/2″-2″
36″	36″	3/16″-1 1/8″	2″-6″	1/2″-2″
42″	42″	3/16″-1 1/8″	2″-6″	3/4″-2″
48″	48″	3/16″-1 1/8″	2″-6″	3/4″-2″
54″	54″	3/16″-1 1/8″	2″-6″	3/4″-2″
60″	60″	3/16″-1 1/4″	2″-6″	3/4″-2 1/2″
66″	66″	1/4″-3/4″	2″-5″	3/4″-1 1/2″
72″	72″	1/4″-1 1/4″	2″-7″	3/4″-2 1/2″
78″	78″	1/4″-1 1/4″	2″-8″	3/4″-2 1/2″
84″	84″	1/4″-1 1/4″	2″-8″	3/4″-2 1/2″
90″	90″	1/4″-1/2″	2″-5″	3/4″-1″
96″	96″	1/4″-1/2″	2″-5″	3/4″-1″
102″	102″	1/4″-1/2″	2″-5″	3/4″-1″
108″	108″	5/16″-3/4″	2″-6″	3/4″-1 1/2″
114″	114″	5/16″-3/4″	2″-6″	3/4″-1 1/2″
120″	120″	5/16″-1″	2″-6″	3/4″-1 1/2″
126″	130″	3/8″-1″	2″-5 1/2″	3/4″-1″
132″	132″	3/8″-1/2″	2″-5 1/2″	3/4″-1″
132″	130″	3/8″-1 1/2″	2″-8″	1 1/2″-3″
144″	144″	3/8″-1 1/2″	2″-8″	3/4″-3″



Flanged and Dished A. S. M. E. Code Head 15′-2 3/4″ O.D.—1 3/8″ Thick. Weight 15,845 Lbs. Used by L. I. W. on Vulcanizer for Large Rubber Company.

STANDARD A. S. M. E. CODE FLANGED AND DISHED HEADS

MINIMUM GAUGE WILL TAKE MINIMUM STRAIGHT FLANGE

O.D.	T	R	r	B	O.D.	T	R	r	B
Outside Diameter	Gauge Min. Max.	Radius of Dish	Inside Corner Radius	Straight Flange	Outside Diameter	Gauge Min. Max.	Radius of Dish	Inside Corner Radius	Straight Flange
12″	3/16″-1/4″	12″	3/4″	1 1/2″-2″	72″	5/16″-9/16″	72″	4 3/8″	1 1/2″-4 1/2″
12″	5/16″-3/4″	12″	3 x T	1 1/2″-3 1/2″	72″	5/8″-1 3/8″	66″	4 3/8″	1 1/2″-7″
18″	3/16″-5/16″	18″	1 1/8″	1 1/2″-2 1/2″	72″	1 1/2″-3″	66″	3 x T	1 1/2″-8″
18″	3/8″-15/16″	16″	3 x T	1 1/2″-3 1/2″	78″	5/16″-3/8″	78″	4 1/16″	1 1/2″-3″
18″	1/2″-1 1/8″	18″	3 x T	1 1/2″-4″	78″	7/16″-1 1/2″	72″	4 15/16″	1 1/2″-8″
24″	3/16″-3/8″	24″	1 1/2″	1 1/2″-3″	78″	1 9/16″-3″	72″	3 x T	1 1/2″-8″
24″	7/16″-1/2″	20″	1 1/2″	1 1/2″-4″	84″	5/16″-3/8″	84″	5 1/16″	1 1/2″-3″
24″	9/16″	20″	3 x T	1 1/2″-4″	84″	7/16″-1 5/8″	78″	5 1/16″	1 1/2″-8″
24″	5/8″-7/8″	18″	3 x T	1 1/2″-5″	84″	1 3/4″-3″	78″	3 x T	1 1/2″-8″
24″	15/16″-1 1/2″	24″	3 x T	1 1/2″-5″	90″	5/16″-3/8″	90″	5 7/16″	1 1/2″-3″
30″	3/16″-9/16″	30″	1 13/16″	1 1/2″-4″	90″	7/16″-1 3/4″	84″	5 7/16″	1 1/2″-8″
30″	5/8″-1″	26″	3 x T	1 1/2″-5 1/2″	90″	1 7/8″-3 1/2″	84″	3 x T	1 1/2″-8″
30″	1 1/16″-1 7/8″	30″	3 x T	1 1/2″-6″	96″	3/8″	96″	5 13/16″	1 1/2″-3″
36″	3/16″-7/16″	36″	2 3/16″	1 1/2″-3 1/2″	96″	7/16″-1 7/8″	90″	5 13/16″	1 1/2″-8″
36″	1/2″-11/16″	33″	2 3/16″	1 1/2″-4″	96″	2″-4″	84″	3 x T	1 1/2″-8″
36″	3/4″	33″	2 1/4″	1 1/2″-6″	102″	3/8″	102″	6 1/8″	1 1/2″-3″
36″	13/16″-1″	33″	3 x T	1 1/2″-6″	102″	7/16″-15/16″	96″	6 1/8″	1 1/2″-8″
36″	1 1/16″-2 1/4″	36″	3 x T	1 1/2″-6″	102″	7/8″-2″	90″	6 1/8″	1 1/2″-8″
42″	3/16″-7/16″	42″	2 9/16″	1 1/2″-4″	102″	2 1/8″-3″	90″	3 x T	1 1/2″-8″
42″	1/2″-15/16″	40″	2 9/16″	1 1/2″-5″	108″	7/16″-15/16″	102″	6 1/2″	1 1/2″-8″
42″	7/8″-1″	40″	3 x T	1 1/2″-7″	108″	7/8″-2 1/8″	96″	6 1/2″	1 1/2″-8″
42″	1 1/16″-2 1/2″	42″	3 x T	1 1/2″-7″	108″	2 1/4″-2 3/4″	96″	3 x T	1 1/2″-8″
48″	1/4″-5/8″	48″	2 15/16″	1 1/2″-4″	108″	2 15/16″-3″	102″	3 x T	1 1/2″-8″
48″	11/16″-15/16″	42″	2 15/16″	1 1/2″-5 1/2″	114″	7/16″-15/16″	108″	6 7/8″	1 1/2″-8″
48″	1″-1 1/2″	42″	3 x T	1 1/2″-7″	114″	7/8″-2 1/4″	102″	6 7/8″	1 1/2″-8″
48″	1 9/16″-2 5/8″	48″	3 x T	1 1/2″-7″	114″	2 3/8″-3″	102″	3 x T	1 1/2″-8″
54″	1/4″-5/8″	54″	3 1/4″	1 1/2″-4″	120″	3/4″-1″	114″	7 1/4″	1 1/2″-8″
54″	11/16″-1″	48″	3 1/4″	1 1/2″-6″	120″	1 1/16″-2 3/8″	108″	7 1/4″	1 1/2″-8″
54″	1 1/16″-2″	48″	3 x T	1 1/2″-7″	120″	2 1/2″-3″	108″	3 x T	1 1/2″-8″
54″	2 1/16″-2 5/8″	54″	3 x T	1 1/2″-7″	126″	7/16″-1 9/16″	120″	7 1/2″	1 1/2″-8″
60″	1/4″-9/16″	60″	3 5/8″	1 1/2″-4 1/2″	126″	1 5/8″-2 1/2″	114″	7 1/2″	1 1/2″-8″
60″	5/8″-1 1/8″	54″	3 5/8″	1 1/2″-6″	126″	2 5/8″-3″	114″	3 xT	1 1/2″-8″
60″	1 1/4″-2 3/4″	54″	3 x T	1 1/2″-7″	132″	7/16″-2 5/8″	120″	8″	1 1/2″-8″
66″	5/16″-1 1/2″	66″	4″	1 1/2″-4 1/2″	132″	2 11/16″-3″	120″	3 x T	1 1/2″-8″
66″	9/16″-1 1/4″	60″	4″	1 1/2″-7″	144″	7/16″-2 7/8″	132″	8 3/4″	1 1/2″-8″
66″	1 15/16″-2 7/8″	60″	3 x T	1 1/2″-7″	144″	2 15/16″-3″	132″	3 x T	1 1/2″-8″
					156″	7/16″-3″	144″	9 3/8″	1 1/2″-8″

STANDARD A. S. M. E. CODE ELLIPTICAL HEADS

MINIMUM GAUGE WILL TAKE MINIMUM STRAIGHT FLANGE. STRAIGHT FLANGE MAY BE INCREASED IN PROPORTION TO GAUGE. MAJOR : MINOR AXIS = 2 : 1

I.D.	T	G	F	I.D.	T	G	F
Inside Diam.	Gauge Min. Max.	Straight Flange	Depth Dish ¼ of I.D.	Inside Diam.	Gauge Min. Max.	Straight Flange	Depth Dish ¼ of I.D.
18″	¼″-⅝″	3½″-5″	4½″	70″	½″-6″	4″-7″	17½″
24″	¼″-⅞″	3½″-5″	6″	72″	½″-6″	4″-7″	18″
28″	¼″-⅞″	3½″-5″	7″	78″	½″-6″	5″-7″	19½″
29″	¼″-⅞″	3½″-5″	7¼″	84″	½″-6″	5″-7″	21″
30″	¼″-⅞″	3½″-5″	7½″	85″	½″-6″	5″-7″	21¼″
32″	5/16″-2″	3½″-6″	8″	90″	9/16″-5½″	5″-8″	22½″
35″	5/16″-2″	3½″-6″	8¾″	95″	9/16″-5″	5″-8″	23¾″
36″	5/16″-2″	3½″-6″	9″	96″	9/16″-5″	5″-8″	24″
38″	⅜″-2″	3½″-6″	9½″	100″	9/16″-4″	5″-8″	25″
40″	⅜″-2½″	3½″-7″	10″	102″	9/16″-4″	5″-8″	25½″
42″	⅜″-2½″	3½″-7″	10½″	108″	9/16″-4″	5″-8″	27″
44″	⅜″-3″	3½″-7″	11″	111″	9/16″-4″	5″-8″	27¾″
45″	⅜″-3″	3½″-7″	11¼″	114″	9/16″-4″	5″-8″	28½″
48″	⅜″-3″	3½″-7″	12″	119″	9/16″-4″	5″-8″	29¾″
51½″	⅜″-3½″	4″-7″	12⅞″	120″	9/16″-4″	5″-8″	30″
52½″	⅜″-3½″	4″-7″	13⅛″	122″	⅝″-4″	5″-8″	30½″
53″	⅜″-4″	4″-7″	13¼″	126″	11/16″-3⅞″	5″-8″	31½″
54″	⅜″-4″	4″-7″	13½″	129″	¾″-3⅞″	5″-8″	32¼″
58″	⅜″-5″	4″-7″	14¼″	132″	¾″-3⅞″	5″-8″	33″
60″	⅜″-6″	4″-7″	15″	141″	13/16″-3⅞″	5″-8″	35¼″
66″	⅜″-6″	4″-7″	16½″	144″	13/16″-3⅞″	5″-8″	36″
69″	7/16″-6″	4″-7″	17¼″	156″	⅞″-2½″	3″-3″	39″

CAPACITY OF ONE FULL HEAD IN GALLONS

(Not Including Straight Flanges)

I.D.	Standard F and D Type	Elliptical Type
1′-6″	1.36	3.22
2′-0″	3.22	7.64
2′-6″	6.30	14.91
3′-0″	10.88	25.77
3′-6″	17.28	40.93
4′-0″	25.79	61.09
4′-6″	36.73	86.98
5′-0″	50.38	119.31
5′-6″	67.05	158.81
6′-0″	87.05	206.17
6′-6″	110.68	262.13
7′-0″	138.23	327.39
7′-6″	170.02	402.68
8′-0″	206.35	488.70
8′-6″	247.49	586.19
9′-0″	293.79	695.83
9′-6″	345.52	818.00
10′-0″	403.00	954.50
10′-6″	466.52	1109.96
11′-0″	536.39	1270.44
11′-6″	612.91	1451.68
12′-0″	696.38	1649.38
12′-6″	787.11	1864.26
13′-0″	885.39	2097.04
13′-6″	991.53	2348.43
14′-0″	1105.83	2619.15
14′-6″	1228.60	2909.91
15′-0″	1360.13	3221.44
15′-6″	1500.72	3554.44
16′-0″	1650.69	3909.63
16′-6″	1810.33	4287.73
17′-0″	1979.94	4689.46
17′-6″	2159.83	5115.52
18′-0″	2350.30	5566.64
18′-6″	2551.64	6043.54
19′-0″	2764.18	6546.92
19′-6″	2988.19	7077.50
20′-0″	3224.00	7636.00
	$.403D^3$ (D = I.D. in Feet)	$.9545D^3$ (D = I.D. in Feet)

LINED TANKS

Lancaster Steel Tanks can be furnished with special linings or coatings for resistance to corrosive acids, brines, etc.

LEAD LINED TANKS

Homogeneous lead linings completely bonded to steel tanks, guaranteed to withstand temperature and pressure changes, vacuum, vibration, etc. Suitable for resistance against bleach liquors, chlorine gas, hydrofluoric acid, mixed acids, sulphuric acid, etc.

RUBBER LINED TANKS

Hard rubber or soft rubber tank linings can be installed in tanks of any size or shape, giving complete protection for resistance against acids, alkalies, caustic solutions, foods, etc. Used in many process industries.

GLASS LINED TANKS

Single shell or jacketed tanks, open or closed top tanks of various sizes can be furnished by LANCASTER highly resistant to all acids except hydrofluoric. Extremely successful for chemical industry requirements and in constant use with the brewing, dairy and food industries.

METAL CLAD LININGS

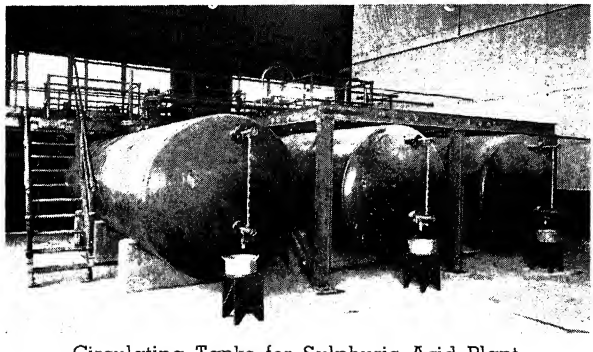
Metal clad tanks, with the corrosive resistant metal rolled directly upon the steel and bonded firmly are furnished by LANCASTER with Clad Linings of Stainless Steel, Nickel or Copper, each of these metals being resistant to a particular group of corrosive agents. Consult us regarding the proper metal for your requirements.

COMPOSITION LININGS

Lancaster Tanks can be supplied with PYROFLEX, PLAST-O-LINE or other plastic linings for pickling tubs, caustic soda, acids, salts, etc. These linings adhere firmly to metals or other surfaces and are ideal at temperatures under 250° F. for a large variety of uses in combating corrosion.

GALVANIZED TANKS

We can supply galvanized tanks to ordinary shop-built sizes, using a high grade Prime Western Zinc Spelter. The style of construction governs the maximum sizes to be galvanized unless the tanks are to be galvanized when knocked down. Galvanized tanks are an economical protection against atmospheric and water corrosion.



Circulating Tanks for Sulphuric Acid Plant.

PAINTING TANKS AND PLATE WORK

It is not the purpose of this book to recommend any particular brand of paint, but rather to impress upon the users of fabricated steel plate products the importance of paint as a preservative.

Unless prevented by protective coatings, corrosion gradually starts its deadly work and in time will deteriorate quickly what was originally an attractive job of satisfactory construction.

No paint applied to steel surfaces can be considered satisfactory unless the steel has been subjected to a complete removal of all rust, dirt, mill scale, grease or foreign substances before the paint is applied. Paint should be evenly spread and all surfaces to be painted should be dry and clean. No paint should be applied under bad weather conditions or where the air temperature is below 40° F.

After all preliminary precautions have been observed, it is then a matter of exercising proper selection in the type and color of paint to be applied and to decide upon the number of coats to be used. Our own engineers, if consulted, will gladly furnish proper information on this subject. A good lead and oil coating of the proper mixture is generally considered a superior first coat on ordinary tank work, but even this is subject to argument in some quarters. Some of the bitumastic enamels are highly successful as protective coatings and usually recommend their own solutions as a first coat under the enamel.

Special paints are available for resistance against acids, alkalis, salt water, stack fumes, high temperatures, etc. Special paints are made for use with hot or cold water and will not affect the water taste. A comparatively recent protection against corrosion in water standpipes or storage tanks is the cathodic projection. Electric anodes are placed in the tanks and metallic ions from the anode will go into solution and hydrogen will be released to form a protective film on the tank plates. Minerals in solution in the water will be placed on the tank plates in exchange for some of the iron going into solution. This method has been proving successful, but operates only on the steel plates in immersion.

PAINT ON BURIED STEEL TANKS

The Inspection Department of the Associated Factory Mutual Fire Insurance Co., some years ago conducted wide investigations on the subject of corrosion in underground steel tanks. The results of these investigations are interesting and quite important, and the following extractions are worth consideration:

"The tanks inspected have been in service for periods ranging from eighteen months to twenty-six years and were buried from ten inches to

nine feet below the ground level. The soil surrounding them consisted of sand, gravel, loam, clay, cinders, or mixtures of these, and sometimes contained ground water and in a few cases salt tide water.

"The life of a buried steel tank depends on the kind of protective coating, the type of back-fill, nature of ground water, depth of bury and the existence of stray electrical currents.

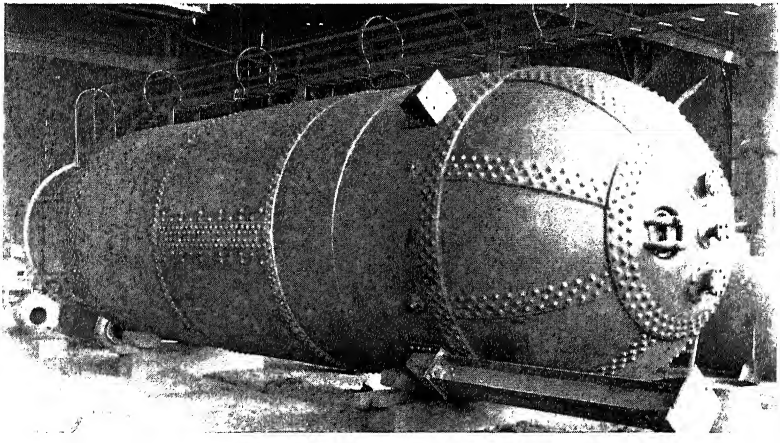
"Experience indicates that the best coating for buried black steel tanks or piping is red lead and linseed oil, applied carefully to a well cleaned metal surface with an outer protective coating of asphalt. Red lead and oil alone, or asphalt alone, give reasonably good protection if the film is unbroken.

"Steel tanks protected by paint and buried under favorable conditions should be serviceable for considerably more than thirty years. Even when buried in poor soil and damp ground, they will last for fifteen to twenty years.

"Types of soil in their order of desirability for fill around steel tanks are as follows:

"(1) Sand; (2) Gravel; (3) Clay; (4) Loam. Cinder fill has been known to cause extremely rapid corrosion and should not be allowed in the vicinity of buried steel. Coal piles should not be located over oil tanks or piping.

"Where the soil contains corrosive substances special protection may be required. This may be accomplished by back filling with moist clay well rammed, or by coating the entire tank with a shell of reinforced concrete."



Vertical High Pressure Gas Holder
10' dia. x 33'-6" high
(For larger sizes see Page 45)

HIGH PRESSURE HOLDERS

STANDARD VERTICAL HIGH PRESSURE GAS HOLDERS

Storage Capacity Available at Various Pressures

Dia. and Height above Foundation	Volume Cubic Ft.	@ 30# Cubic Ft.	@ 40# Cubic Ft.	@ 50# Cubic Ft.	@ 60# Cubic Ft.	@ 70# Cubic Ft.	@ 80# Cubic Ft.	@ 90# Cubic Ft.	@ 100# Cubic Ft.
20′0″ x 63′ 0″	17,000	34,700	46,200	57,800	69,400	80,900	92,500	104,000	115,600
20′0″ x 72′ 3″	20,000	40,800	54,400	68,000	81,600	95,200	108,800	122,400	136,000
24′0″ x 65′ 1″	25,000	51,000	68,000	85,000	102,000	119,000	136,000	153,000	170,000
24′0″ x 76′ 5″	30,000	61,200	81,600	102,000	122,400	142,800	163,200	183,600	204,000
30′0″ x 61′ 7″	35,000	71,400	95,200	119,000	142,800	166,600	190,400	214,200	.....
30′0″ x 68′ 8″	40,000	81,600	108,800	136,000	163,200	190,400	217,700	244,900	.....
30′0″ x 75′ 9″	45,000	91,800	122,400	153,000	183,600	214,200	244,900	275,500	.....
30′0″ x 82′10″	50,000	102,000	136,000	170,000	204,000	238,100	272,100	306,100	.....
32′0″ x 74′10″	50,000	102,000	136,000	170,000	204,000	238,100	272,100	.....	.....
32′0″ x 87′ 4″	60,000	122,400	163,000	204,000	244,800	285,700	326,500	.....	.....
38′0″ x 80′10″	75,000	153,000	204,000	255,000	306,000	357,100	.....	.....	.....
38′0″ x 89′ 8″	85,000	173,400	231,200	289,000	346,800	404,600	.....	.....	.....
38′0″ x 102′10″	100,000	204,000	272,000	340,000	408,000	476,200	.....	.....	.....

Height includes two feet between bottom of tank and foundation.

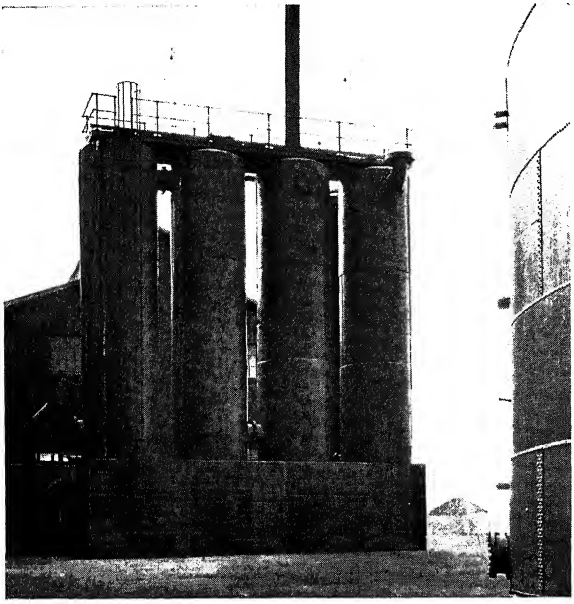
Tanks of various other diameters and heights to best suit Purchaser's requirements.

STANDARD HORIZONTAL HIGH PRESSURE GAS HOLDERS

Storage Capacity Available at Various Pressures

Dia. and Length Overall	Volume Cubic Ft.	@ 30# Cubic Ft.	@ 40# Cubic Ft.	@ 50# Cubic Ft.	@ 60# Cubic Ft.	@ 70# Cubic Ft.	@ 80# Cubic Ft.	@ 90# Cubic Ft.	@ 100# Cubic Ft.
18′0″ x 45′3″	10,000	20,400	27,200	34,000	40,800	47,600	54,400	61,200	68,000
18′0″ x 65′0″	15,000	30,600	40,800	51,000	61,200	71,400	81,600	91,800	102,000
20′0″ x 61′0″	17,000	34,700	46,200	57,800	69,400	80,900	92,500	104,000	115,600
20′0″ x 70′3″	20,000	40,800	54,400	68,000	81,600	95,200	108,800	122,400	136,000
20′0″ x 86′3″	25,000	51,000	68,000	85,000	102,000	119,000	136,000	153,000	170,000
24′0″ x 63′1″	25,000	51,000	68,000	85,000	102,000	119,000	136,000	153,000	170,000
20′0″ x 111′0″	32,777	66,900	89,200	111,400	133,800	156,000	178,300	200,600	222,900
24′0″ x 80′3″	32,723	66,800	89,000	111,300	133,400	155,800	178,100	200,300	222,600
24′0″ x 96′6″	40,000	81,600	108,800	136,000	163,200	190,400	217,700	244,900	272,100
24′0″ x 118′6″	50,000	102,000	136,000	170,000	204,000	238,100	272,100	306,100	340,100
27′0″ x 96′4″	50,000	102,000	136,000	170,000	204,000	238,100	272,100	306,100	340,100
24′0″ x 140′8″	60,000	122,400	163,000	204,000	244,800	285,700	326,500	367,300	408,100
27′0″ x 113′9″	60,000	122,400	163,000	204,000	244,800	285,700	326,500	367,300	408,100
27′0″ x 140′0″	75,000	153,000	204,000	255,000	306,000	357,100	408,100	459,200	510,200
30′0″ x 116′2″	75,000	153,000	204,000	255,000	306,000	357,100	408,100	459,200	.....
32′0″ x 135′0″	100,000	204,000	272,000	340,000	408,000	476,200	544,200	.....	.....
32′0″ x 166′1″	125,000	255,000	340,000	425,000	510,000	595,200	680,200	.....	.....
32′0″ x 197′2″	150,000	306,000	408,000	510,000	612,000	714,300	816,300	.....	.....

SULPHURIC ACID STORAGE TANKS—VERTICAL TYPE



Building Acid Storage Tanks is quite another thing from the fabrication of ordinary Steel Plate Work. Only the most experienced shop and field workmen can be used. In our organization are men who have specialized on Acid-Plant construction and we are well able to take care of any requirements for such work.

Absorption and Scrubber Towers 7½ ft. x 31½ ft.
At extreme right 50 ft. diameter Acid Storage Tank.

PRINCIPAL USES OF SULPHURIC ACID

For decomposing salts with the production of nitric acid, hydrochloric acid and sodium sulphate, thus indirectly in manufacturing soda ash, soap, glass, etc.

For the purification of oils—petroleum, tar oils, etc.

For pickling iron articles previous to tinning or galvanizing.

As a drying agent in the production of organic dyes, on which the textile industry depends.

For rendering soluble mineral and animal phosphate for manures for agriculture.

For the manufacture of nitric acid from saltpetre.

Sulphuric acid forms the starting point of or is used in almost every important industry.

Degrees Baumé	Specific Gravity	Per Cent H_2SO_4	Weight of 1 Cu. Ft. Pounds	Gallons Per Ton	Cu. Feet Per Ton	Weight Per Gal. Pounds
50	1.5263	62.18	95.20	157.1955	21.0084	12.723
55	1.6111	69.65	100.48	148.9203	19.9044	13.430
60	1.7059	77.67	106.40	140.6469	18.7969	14.220
66	1.8354	93.19	114.47	130.7189	17.4718	15.300

WELDING

WELDABILITY OF STEEL

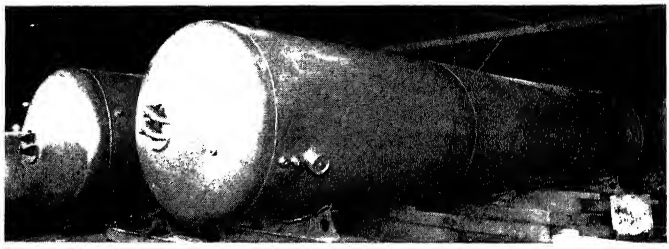
Weldability is associated with the method of welding, the size and shape of the structure involved and the ability to apply special techniques. Given suitable design and freedom to use any welding process and special technique, the statement that all steels are weldable cannot be challenged.

A technical definition has been given as follows:

"The weldability of a steel may be defined as its ability to pass through the thermal cycle of a particular welding technique without the production of hard or brittle zones in the welded joint, which would tend to the production of cracks or to the failure of the welded joints under service loading."

Steels must be properly selected for each individual purpose, particular attention being paid to carbon content. It is an accepted fact that relative weldability decreases with increasing carbon content, even though increasing carbon is accompanied by compensating reduction in manganese content. For a steel of relatively high yield strength the increase in strength from the view-point of weldability is better obtained by compositions involving relatively low carbon and relatively high carbon rather than the reverse.

Lancaster Engineers have kept up with the progress of welding design and applied technique, and you can safely present to us your problems covering welded plate work.



Welded Pressure Vessels 7′ dia. x 38′ long manufactured under Procedure Control.

WELDING TANKS AND PLATE CONSTRUCTION

Tanks are built only by skilled workmen. Qualified welders are employed by us on every job of welded construction. Modern electric shielded arc equipment is used, proper superintendence is employed, and with our unusually broad experience in welding a great variety of metals, a satisfactory job is always assured.

WELDING

Welding is admirably adapted to the fabrication of plate work and vessels of all kinds. The fundamental factors to be considered are:

1. Proper selection of material.
2. Use of good welding wire.
3. Correct design of equipment and joints.
4. Proper preparation of material for welding.
5. Employment of proper technique.
6. Use of qualified welders.

Some of the many advantages of welding may be summarized as follows:

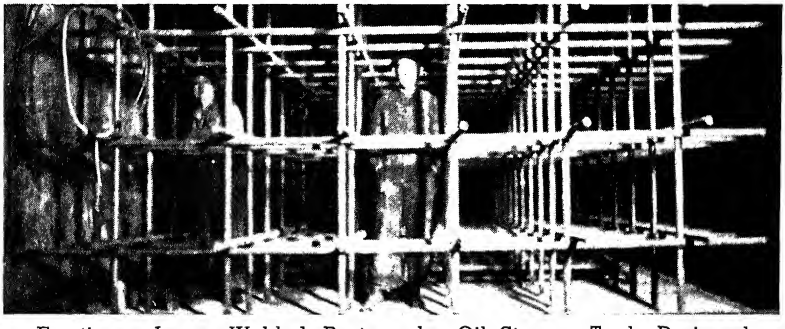
1. Utility of design.
2. Uniform dependable joints of definite strength.
3. Economy of fabrication and ultimate costs.
4. Superiority of finished product.
5. Increased production and quicker deliveries.

WELDED PLATE FABRICATION VS. CASTINGS

The elimination of costly and heavy castings by the substitution of all-welded, rolled steel is not merely an economical result. Many plants have found grief from hidden defects in castings, entailing expensive repairs and losses due to shut-down. This uncertainty is to a great extent eliminated in properly designed and correctly welded plate fabrication.

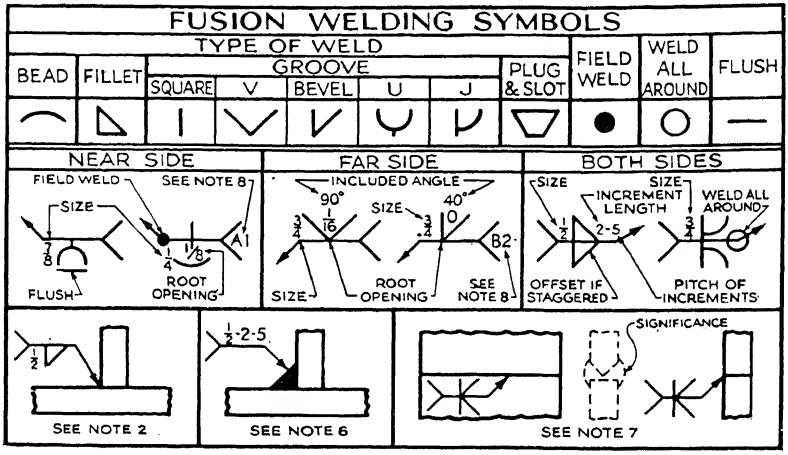
Naturally the ultimate cost is a prime factor, but in addition, the use of welded steel products provides greater strength with less weight and high resistance to deformation and fatigue.

Freedom in design, improvement in appearance, economy in manufacturing, saving in floor space, reduced weight and quicker deliveries, are some of the many advantages of welded plate products used in place of castings.



Erecting a Large, Welded, Rectangular Oil Storage Tank, Designed and Braced for 25 Lbs. Working Pressure

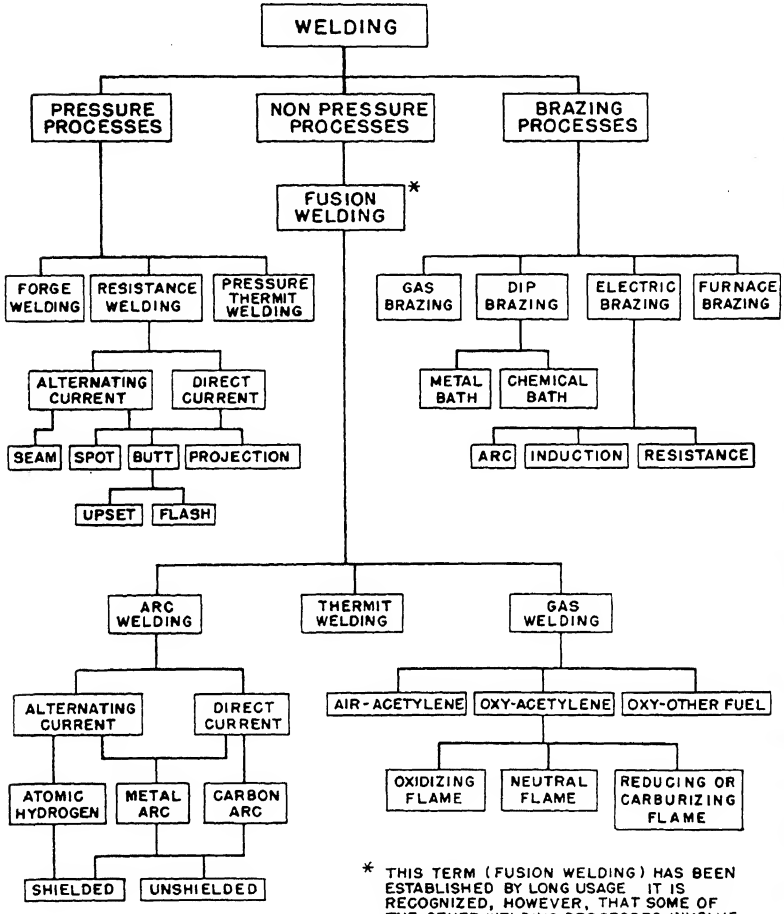
LEGEND FOR USE ON DRAWINGS SPECIFYING FUSION WELDING



1. In plan or elevation, near, far and both sides locations refer to nearest member parallel to plane of drawing and not to others farther behind.
2. In section or end views only, when weld is not drawn the side to which arrow points is considered near side.
3. Welds on both sides are of same size unless otherwise shown.
4. Symbols govern to break in continuity of structure or to extent of hatching or dimension lines.
5. All welds are continuous and of user's standard proportions and all except V- and bevel-grooved welds are closed unless otherwise shown.
6. When welds are drawn in section or end views, obvious information is not given by symbol.
7. In joints in which one member only is to be grooved arrows point to that member.
8. Tail of arrow used for specification reference.

Note: All dimensions are in inches.

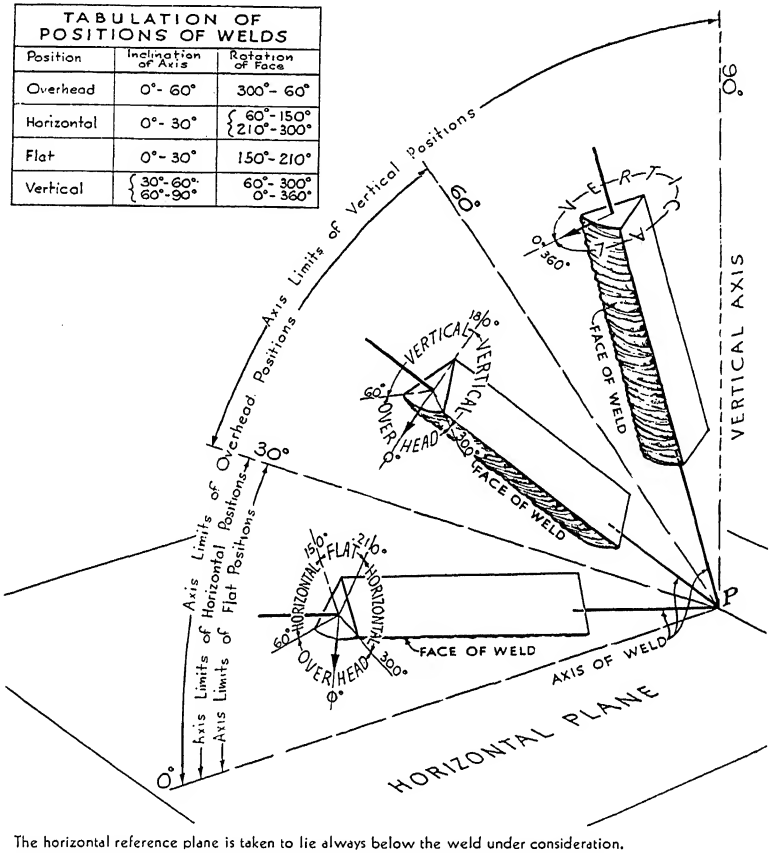
MASTER CHART OF WELDING PROCESSES



* THIS TERM (FUSION WELDING) HAS BEEN ESTABLISHED BY LONG USAGE IT IS RECOGNIZED, HOWEVER, THAT SOME OF THE OTHER WELDING PROCESSES INVOLVE FUSION.

DEFINITIONS OF WELDING TERMS

TABULATION OF POSITIONS OF WELDS		
Position	Inclination of Axis	Rotation of Face
Overhead	0°- 60°	300°- 60°
Horizontal	0°- 30°	{60°- 150° 210°- 300°}
Flat	0°- 30°	150°- 210°
Vertical	{30°- 60° 60°- 90°}	60°- 300° 0°- 360°



The horizontal reference plane is taken to lie always below the weld under consideration.

Inclination of axis is measured from the horizontal reference plane toward the vertical.

Angle of rotation of face is measured from a line perpendicular to the axis of the weld and lying in a vertical plane containing this axis. The reference position (0°) of rotation of the face invariably points in the direction opposite to that in which the axis angle increases. The angle of rotation of the face of weld is measured in a clockwise direction from this reference position (0°) when looking toward point "P."

Fig. 1—Position of Welds

DEFINITIONS OF WELDING TERMS

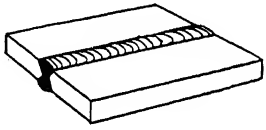


Fig. 2—Butt Joint

Types of Welds Applicable to Butt Joints
Square Groove
Single-V Groove
Double-V Groove (Illustrated)
Single Bevel Groove
Double Bevel Groove
Single-U Groove
Double-U Groove
Single-J Groove
Double-J Groove
Butt (Resistance)

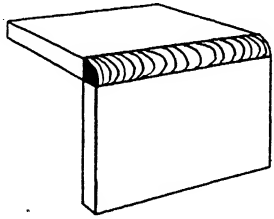


Fig. 3—Corner Joint

Types of Welds Applicable to Corner Joints
Fillet (Illustrated)
Square Groove
Single-V Groove
Single Bevel Groove
Double Bevel Groove
Single-U Groove
Single-J Groove
Double-J Groove
Projection (Resistance)

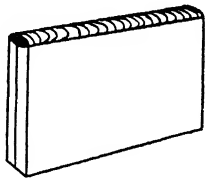


Fig. 4—Edge Joint

Types of Welds Applicable to Edge Joints
Bead (Illustrated)
Single-V Groove
Single-U Groove

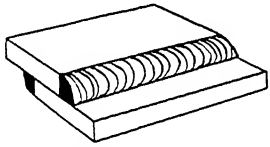


Fig. 5—Lap Joint

Type of Welds Applicable to Lap Joints
Fillet (Illustrated)
Plug
Slot
Spot (Resistance)
Seam (Resistance)
Projection (Resistance)

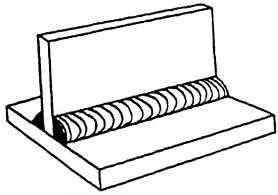


Fig. 6—Tee Joint

Types of Welds Applicable to Tee Joints
Fillet (Illustrated)
Single Bevel Groove
Double Bevel Groove
Single-J Groove
Double-J Groove

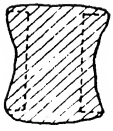


Fig. 7—Square Groove Weld

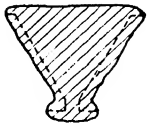


Fig. 8—Single-V Groove Weld

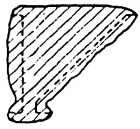


Fig. 9—Single Bevel Groove Weld

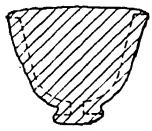


Fig. 10—Single-U Groove Weld

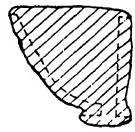


Fig. 11—Single-J Groove Weld

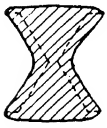


Fig. 12—Double-V Groove Weld

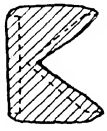


Fig. 13—Double Bevel Groove Weld

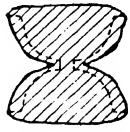


Fig. 14—Double-U Groove Weld

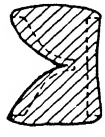


Fig. 15—Double-J Groove Weld

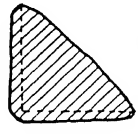


Fig. 16—Fillet Weld

DEFINITIONS OF WELDING TERMS

Fig. 17—Bead Weld

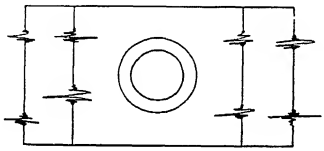


Fig. 18—Plug Weld

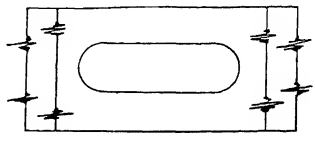


Fig. 19—Slot Weld

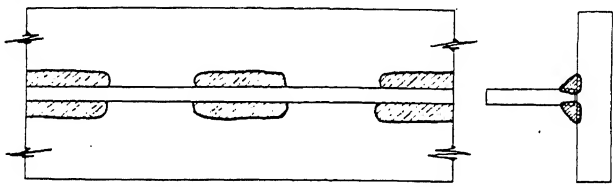


Fig. 20—Chain Intermittent Fillet Welds

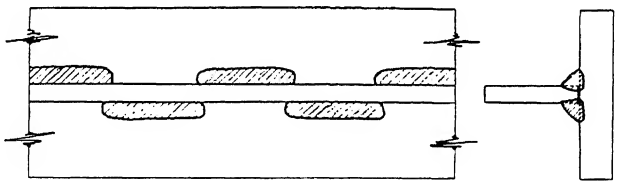


Fig. 21—Staggered Intermittent Fillet Welds

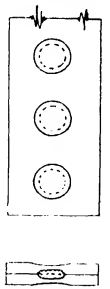


Fig. 22—Spot Weld

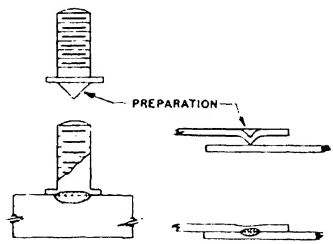


Fig. 23—Projection Welds

DEFINITIONS OF WELDING TERMS

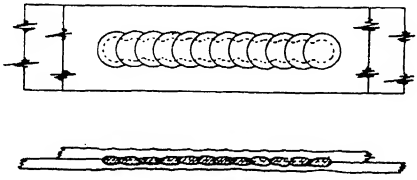


Fig. 24—Seam Weld

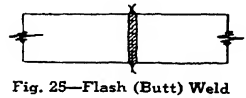


Fig. 25—Flash (Butt) Weld

Fig. 26—Edge Preparation

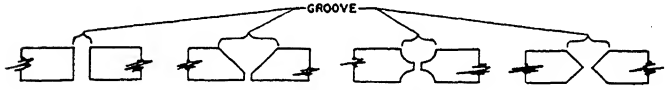


Fig. 27—Groove

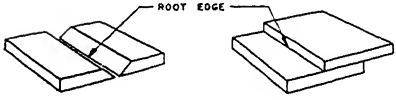


FIG. 28 ROOT EDGE

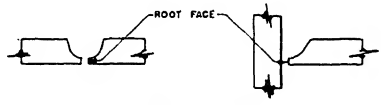


FIG. 29 ROOT FACE

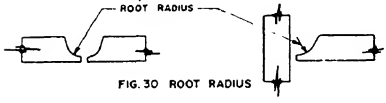


FIG. 30 ROOT RADIUS

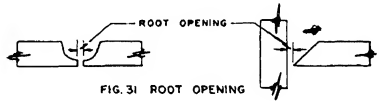


FIG. 31 ROOT OPENING

FIG 32 GROOVE ANGLE

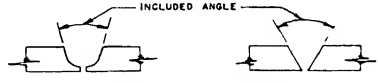


FIG. 33 INCLUDED ANGLE

DEFINITIONS OF WELDING TERMS

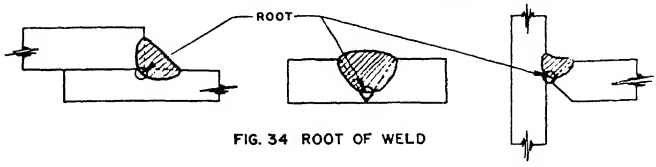


FIG. 34 ROOT OF WELD

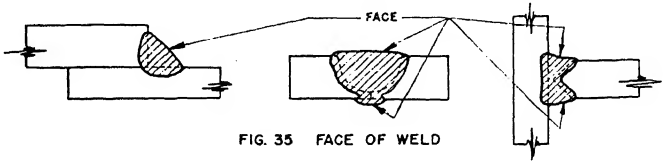


FIG. 35 FACE OF WELD

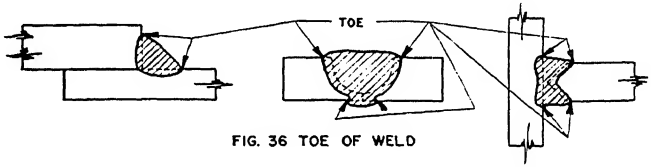


FIG. 36 TOE OF WELD

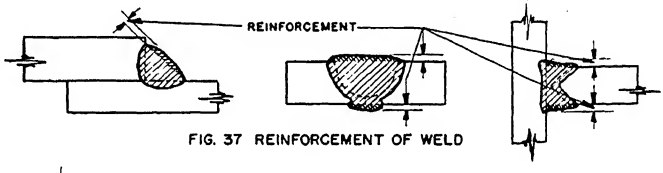


FIG. 37 REINFORCEMENT OF WELD

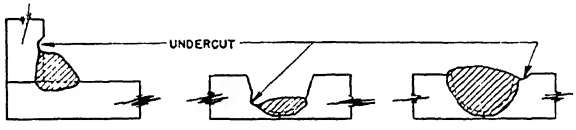


Fig. 38—Undercutting

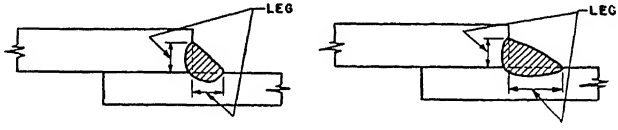


FIG. 39 LEG OF FILLET WELD

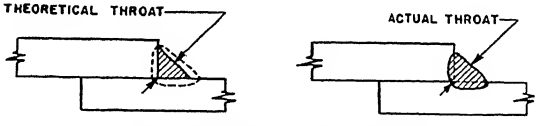
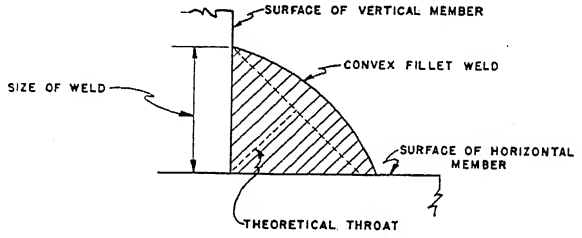
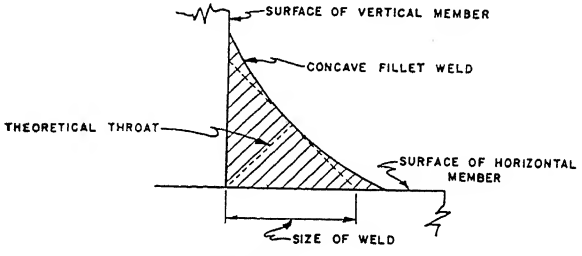


FIG. 40 THROAT OF FILLET WELD

DEFINITIONS OF WELDING TERMS





$$\text{SIZE} = \frac{\text{THROAT}}{.707}$$

NOTE

THE SIZE OF A FILLET WELD IS THE LEG LENGTH OF THE LARGEST INSCRIBED RIGHT ISOSCELES TRIANGLE.

FIG. 41 SIZE OF FILLET WELD

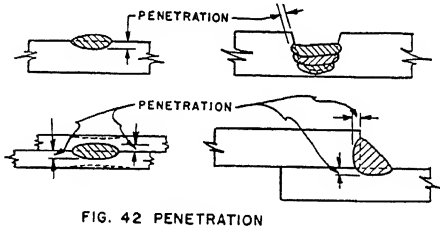


FIG. 42 PENETRATION

FIG. 43 PASSES

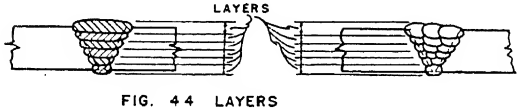


FIG. 44 LAYERS

DEFINITIONS OF WELDING TERMS

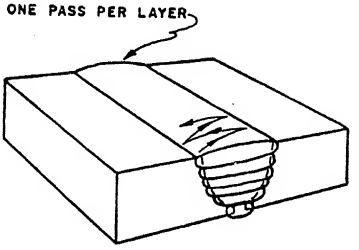


FIG. 45 WEAVING

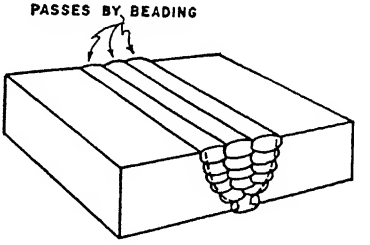
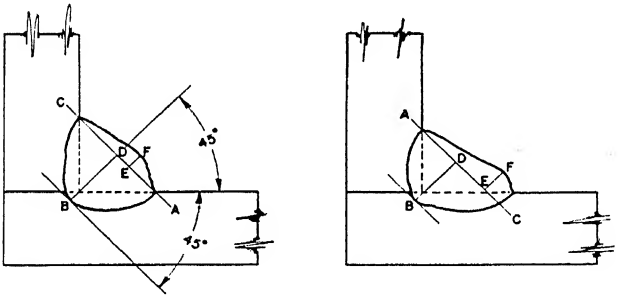
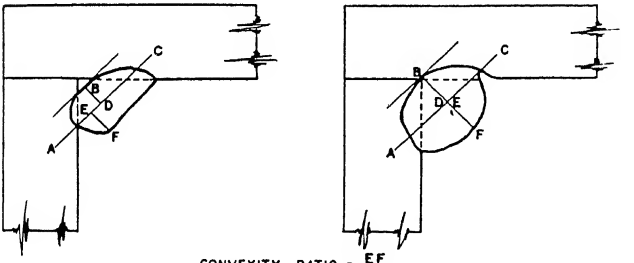


FIG. 46 BEADING



NOTE: LINE AC IS DRAWN INTERNALLY TANGENT TO THE INMOST POINT IN THE FACE OF THE FILLET.



CONVEXITY RATIO = $\frac{EF}{BD}$

Fig. 47—Convexity Ratio

Courtesy American Welding Society

WELDING ELECTRODES

HOW TO USE THESE TABLES

To assist in estimating the approximate weight of various kinds of electrodes needed for various types of welded joints, the following tables have been prepared.

These tables are based on average conditions as outlined below. It should be recognized, therefore, that estimates involving variations from these conditions or from joint preparations as listed in the following pages, necessitate that proper allowances be made accordingly.

METHOD USED IN CALCULATING THESE TABLES

The formula used in calculating electrode requirements is as follows:

$$\text{Weight of Electrodes Required} = \frac{\text{Weight of Steel Deposited}}{1 - \text{Electrode Losses}}$$

The weight of steel deposited is calculated from the volume required to fill the joint, plus reinforcement (if used).

Electrode losses are the sum of (a) the scrap-end loss plus (b) the spatter and flux-coating losses.

(a) For these tables, the scrap-end loss was taken as 17 per cent, which is about average, although this value may vary from 10 to 20 per cent for 14-inch lengths, depending on the care and technique employed.

(b) Likewise, for these tables, spatter and flux-coating losses are as follows:

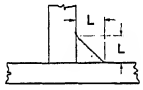
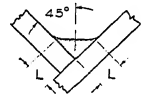
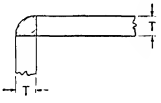
Bare and lightly fluxed electrodes = 13 per cent
Heavily coated electrodes..... = 27 per cent

The former may vary between 8 and 15 per cent and the latter between 15 and 35 per cent, depending on the type and size of electrode, welding position, operator's technique, welding current, and arc voltage. Excessive current increases spatter loss considerably.

Obviously, in cases where all variables are known for the specific application, the above formula may be used to approximate electrode requirements for that application more accurately than using the tables.

ELECTRODE REQUIREMENTS FOR VARIOUS TYPES OF WELDS

(MANUAL WELDING)

TYPE OF WELD	Size of Fillet L	Weight of Electrodes Required in Pounds Per Linear Foot (Approx.) ϕ		Amount of Steel Deposited Per Linear Foot	
		Bare and Thinly Coated	Heavily Coated	Cu. In.	Pounds
NORMAL FILLET  Fig. 1	1/8	0.039	0.048	0.094	0.027
	3/16	0.090	0.113	0.222	0.063
	1/4	0.151	0.189	0.375	0.106
	5/16	0.237	0.296	0.585	0.166
	3/8	0.341	0.427	0.844	0.239
	1/2	0.607	0.760	1.500	0.425
	5/8	0.947	1.185	2.340	0.663
	3/4	1.365	1.705	3.375	0.955
	1	2.420	3.030	6.000	1.698
POSITIONED FILLET  Fig. 2	1/4	.....	0.212	0.420	0.119
	5/16	.....	0.334	0.660	0.187
	3/8	.....	0.486	0.960	0.272
	1/2	.....	0.850	1.680	0.475
	5/8	.....	1.275	2.520	0.713
	3/4	.....	1.820	3.600	1.020
	1	.....	3.210	6.350	1.800
	T Inches				
OUTSIDE CORNER FILLET  Fig. 3	1/8	0.06	0.07	0.144	0.041
	3/16	0.13	0.16	0.336	0.095
	1/4	0.24	0.30	0.588	0.167
	5/16	0.37	0.46	0.923	0.261
	3/8	0.53	0.67	1.335	0.378
	1/2	0.95	1.19	2.350	0.665
	5/8	1.49	1.86	3.680	1.043
	3/4	2.15	2.68	5.300	1.502
	1	3.81	4.77	9.41	2.670

ϕ Includes scrap-end and spatter loss as outlined on page 58.

ELECTRODE REQUIREMENTS FOR VARIOUS TYPES OF WELDS

(MANUAL WELDING)

TYPE OF WELD	Inches			ϕ Weight of Electrodes Required in Pounds Per Linear Foot (Approx.)				Amount of Steel Deposited per Linear Foot			
				Without Reinforcement		*With Reinforcement		Without Reinforcement		*With Reinforcement	
	T	W	S	Bare and Thinly Coated	Heavily Coated	Bare and Thinly Coated	Heavily Coated	Cu. In.	Pounds	Cu. In.	Pounds
SQUARE GROOVE	3/16	3/8	0	....	....	0.13	0.16	....	....	0.312	0.088
			1/16	0.03	0.04	0.16	0.20	0.071	0.020	0.384	0.109
	1/4	7/16	1/16	0.04	0.05	0.19	0.23	0.094	0.027	0.415	0.129
			3/32	0.06	0.07	0.20	0.26	0.140	0.039	0.504	0.143
	5/16	1/2	1/16	0.05	0.06	0.22	0.27	0.118	0.033	0.540	0.153
			3/32	0.07	0.09	0.24	0.30	0.176	0.050	0.600	0.170
SQUARE GROOVE	1/8	1/4	0	....	....	0.17	0.21	....	....	0.42	0.119
			3/32	0.02	0.03	0.19	0.24	0.047	0.013	0.467	0.132
	3/16	3/8	1/32	0.03	0.04	0.28	0.36	0.071	0.020	0.70	0.199
			1/16	0.06	0.07	0.31	0.39	0.141	0.040	0.77	0.218
	1/4	7/16	1/16	0.08	0.10	0.37	0.47	0.188	0.053	0.92	0.261
			3/32	0.12	0.14	0.43	0.53	0.282	0.080	1.02	0.288
SQUARE GROOVE	1/8	1/4	0	....	....	0.09	0.11	....	....	0.210	0.060
			1/16	0.04	0.05	0.12	0.15	0.094	0.027	0.304	0.086
	3/16	3/8	1/16	0.06	0.07	0.18	0.23	0.140	0.040	0.456	0.129
			3/32	0.09	0.11	0.21	0.27	0.211	0.060	0.526	0.149
	1/4	7/16	3/32	0.12	0.14	0.26	0.33	0.282	0.080	0.649	0.184
			1/8	0.15	0.19	0.30	0.38	0.376	0.107	0.742	0.210

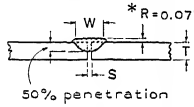


Fig. 4

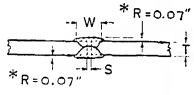


Fig. 5

If underside of top weld is chipped or burned out and welded, add 0.07 lb. to steel deposited (equivalent to approx. 0.10 lb. of thinly coated or 0.13 lb. of heavily coated electrodes.)

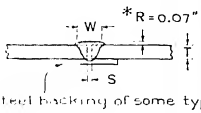


Fig. 6

ϕ Includes scrap-end and spatter loss as outlined on page 58.
* R = Height of reinforcement.

ELECTRODE REQUIREMENTS FOR VARIOUS TYPES OF WELDS

(MANUAL WELDING)

TYPE OF WELD	Inches			Φ Weight of Electrodes Required in Pounds Per Linear Foot (Approx.)				Amount of Steel Deposited per Linear Foot			
				Without Reinforcement		*With Reinforcement		Without Reinforcement		*With Reinforcement	
	T	W	S	Bare and Thinly Coated	Heavily Coated	Bare and Thinly Coated	Heavily Coated	Cu. In.	Pounds	Cu. In.	Pounds
"V" GROOVE	1/4	0.405		0.33	0.41	0.49	0.61	0.815	0.231	1.200	0.340
	5/16	0.476		0.46	0.58	0.65	0.81	1.14	0.323	1.595	0.452
	3/8	0.549		0.62	0.77	0.83	1.03	1.521	0.432	2.04	0.577
	1/2	0.693		1.00	1.25	1.26	1.58	2.460	0.696	3.12	0.882
	5/8	0.838		1.46	1.82	1.78	2.23	3.600	1.020	4.40	1.248
	3/4	0.982		2.00	2.50	2.39	3.00	4.960	1.405	5.91	1.675
	1	1.273		3.40	4.23	3.87	4.83	8.350	2.370	9.57	2.710
"V" GROOVE	1/4	0.207	1/16	0.12	0.15	0.20	0.25	0.300	0.085	0.504	0.143
	5/16	0.311	3/32	0.25	0.31	0.37	0.46	0.611	0.173	0.911	0.258
	3/8	0.414	1/8	0.40	0.50	0.56	0.70	0.995	0.282	1.390	0.394
	1/2	0.558	1/8	0.70	0.87	0.91	1.15	1.730	0.489	2.263	0.641
	5/8	0.702	1/8	1.08	1.35	1.35	1.68	2.660	0.753	3.330	0.942
	3/4	0.847	1/8	1.55	1.94	1.88	2.35	3.840	1.088	4.650	1.320
	1	1.138	1/8	2.76	3.45	3.20	4.00	6.810	1.930	7.90	2.240
"V" GROOVE	1/4	0.207	1/16	....	....	0.32	0.41	....	....	0.815	0.231
	5/16	0.311	3/32	....	....	0.49	0.62	....	....	1.225	0.346
	3/8	0.414	1/8	....	....	0.68	0.85	....	....	1.680	0.475
	1/2	0.558	1/8	....	....	1.16	1.45	....	....	2.870	0.811
	5/8	0.702	1/8	....	....	1.59	1.99	....	....	3.940	1.115
	3/4	0.847	1/8	....	....	2.13	2.66	....	....	5.250	1.490
	1	1.138	1/8	....	....	3.44	4.30	....	....	8.500	2.410

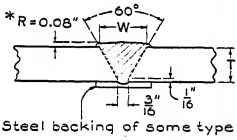


Fig. 7

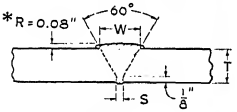


Fig. 8

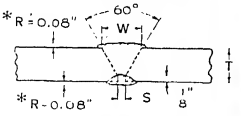


Fig. 9
Underside of weld chipped or burned out and welded.

Φ Includes scrap-end and spatter loss as outlined on page 58.
* R = Height of reinforcement.

ELECTRODE REQUIREMENTS FOR VARIOUS TYPES OF WELDS
(MANUAL WELDING)

TYPE OF WELD	Inches		Weight of Electrodes Required in Pounds Per Linear Foot (Approx.)				Amount of Steel Deposited Per Linear Foot			
			Without Reinforcement		*With Reinforcement		Without Reinforcement		*With Reinforcement	
	T	W	Bare and Thinly Coated	Heavily Coated	Bare and Thinly Coated	Heavily Coated	Cu. In.	Pounds	Cu. In.	Pounds
DOUBLE "V" GROOVE	5/8	0.405	0.72	0.90	1.03	1.29	1.775	0.502	2.56	0.724
	3/4	0.468	0.98	1.22	1.34	1.68	2.410	0.682	3.31	0.937
1		0.630	1.68	2.10	2.17	2.71	4.150	1.175	5.36	1.520
1 1/4		0.774	2.53	3.17	3.13	3.92	6.27	1.775	7.75	2.195
1 1/2		0.919	3.56	4.45	4.28	5.35	8.85	2.495	10.59	3.00
1 3/4		1 063	4.77	5.95	5.58	6.98	11.80	3.335	13.82	3.91
2		1 207	6.13	7.68	7.10	8.88	15.20	4.30	17.58	4.97
2 1/4		1.352	7.70	9.60	8.75	10.95	19.00	5.38	21.65	6.12
2 1/2		1.496	9.43	11.80	10.60	13.20	23.30	6.60	26.20	7.40
3		1.784	13.36	16.70	14.75	18.50	33.00	9.35	36.50	10.33
3 1/2		2.073	18.10	22.60	19.70	24.60	44.70	12.65	48.70	13.80
4		2.368	23.50	29.40	25.40	31.70	58.15	16.45	62.80	17.80

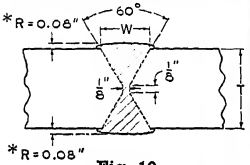


Fig. 10

If underside of top weld is chipped or burned out and welded, add 0.10 lb. to steel deposited (equivalent to approx. 0.14 lb. thinly coated or 0.18 lb. of heavily coated electrodes.)

"U" GROOVE										
	1/2	0.652	....	1.18	....	1.49	2.325	0.659	2.95	0.835
	5/8	0.705	....	1.70	....	2.04	3.345	0.947	4.02	1.140
	3/4	0.758	....	2.24	....	2.61	4.435	1.255	5.17	1.465
1		0.865	....	3.47	....	3.89	6.870	1.945	7.70	2.180
1 1/4		0.971	....	4.86	....	5.35	9.62	2.72	10.60	3.00
1 1/2		1.077	....	6.41	....	6.95	12.66	3.59	13.72	3.89
1 3/4		1.173	....	8.08	....	8.65	16.00	4.53	17.10	4.84
2		1.292	....	10.00	....	10.65	19.75	5.60	21.04	5.96
2 1/4		1.396	....	12.05	....	12.75	23.80	6.75	25.20	7.12
2 1/2		1 502	....	14.25	....	15.00	28.20	7.98	29.65	8.40
2 3/4		1.608	....	16.60	....	17.40	32.80	9.29	34.65	9.73
3		1.715	....	19.10	....	20.00	37.80	10.70	39.45	11.19
3 1/2		1.927	....	24.70	....	25.50	48.60	13.80	50.50	14.30
4		2.140	....	30.90	....	31.90	61.00	17.30	63.10	17.90

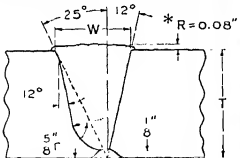


Fig. 11

If underside of weld is chipped or burned out and welded, add 0.19 lb. to steel deposited (equivalent to approx. 0.27 lb. of thinly coated or 0.34 lb. of heavily coated electrodes).

MODIFIED "U" GROOVE										
	1/2									
	5/8									
	3/4									
1										
1 1/4										
1 1/2										
1 3/4										
2										
2 1/4										
2 1/2										
2 3/4										
3										
3 1/2										
4										

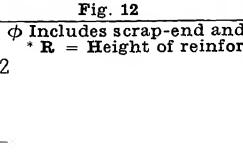


Fig. 12

For irregular shapes, preparation of the modified "U" groove is usually more economical than the regular "U" groove (Fig. 11).

Approx. 5 per cent more electrode must be used to fill the joint than for the regular "U" groove.

ϕ Includes scrap-end and spatter loss as outlined on page 58.

* **R** = Height of reinforcement.

ELECTRODE REQUIREMENTS FOR VARIOUS TYPES OF WELDS
(MANUAL WELDING)

TYPE OF WELD	Inches		Weight of Electrodes Required in Pounds Per Linear Foot (Approx.) ϕ				Amount of Steel Deposited Per Linear Foot			
			Without Reinforcement		*With Reinforcement		Without Reinforcement		*With Reinforcement	
	T	W	Bare and Thinly Coated	Heavily Coated	Bare and Thinly Coated	Heavily Coated	Cu. In.	Pounds	Cu. In.	Pounds
DOUBLE "U"	1	0.685	....	2.86	....	3.54	5.64	1.60	6.96	1.98
	1¼	0.731	....	3.91	....	4.62	7.75	2.19	9.15	2.59
	1½	0.784	....	5.05	....	5.83	10.00	2.83	11.55	3.27
	1¾	0.838	....	6.30	....	7.12	12.47	3.53	14.10	3.99
	2	0.891	....	7.60	....	8.46	15.08	4.26	16.74	4.74
	2¼	0.944	....	9.00	....	9.90	17.80	5.04	19.60	5.55
	2½	0.997	....	10.45	....	11.45	20.70	5.85	22.60	6.41
	2¾	1.050	....	12.00	....	13.05	23.80	6.73	25.80	7.30
	3	1.103	....	13.85	....	14.90	27.15	7.75	29.40	8.34
	3½	1.211	....	17.20	....	18.40	33.98	9.61	36.30	10.30
	4	1.316	....	21.00	....	22.30	41.55	11.75	44.00	12.50
BEVEL GROOVE	1/4	0.125	0.04	0.05	0.08	0.10	0.096	0.027	0.216	0.061
	5/16	0.188	0.09	0.11	0.16	0.20	0.216	0.061	0.396	0.112
	3/8	0.250	0.15	0.19	0.25	0.31	0.372	0.106	0.611	0.173
	1/2	0.375	0.34	0.43	0.49	0.61	0.840	0.238	1.211	0.343
	5/8	0.500	0.61	0.76	0.80	1.00	1.500	0.425	1.980	0.560
	3/4	0.625	0.95	1.19	1.19	1.50	2.340	0.663	2.950	0.835
	1	0.875	1.86	2.33	2.25	2.81	4.590	1.303	5.57	1.575
DOUBLE-BEVEL GROOVE	1/2	0.188	0.17	0.22	0.32	0.39	0.42	0.120	0.78	0.221
	5/8	0.250	0.30	0.38	0.50	0.62	0.756	0.213	1.238	0.350
	3/4	0.313	0.48	0.59	0.72	0.90	1.175	0.332	1.775	0.503
	1	0.438	0.93	1.16	1.27	1.58	2.294	0.648	3.130	0.886
	1 1/4	0.563	1.54	1.92	1.97	2.46	3.790	1.076	4.870	1.38
	1 1/2	0.688	2.30	2.87	2.83	3.54	5.670	1.607	7.00	1.98
	1 3/4	0.813	3.21	4.01	3.83	4.78	7.92	2.245	9.47	2.68
	2	0.938	4.27	5.33	5.00	6.25	10.53	2.985	12.33	3.50

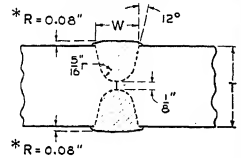


Fig. 13
If underside of top weld is chipped or burned out and welded, add 0.19 lb. to steel deposited (equivalent to approx. 0.27 lb. of thinly coated or 0.34 lb. of heavily coated electrodes).

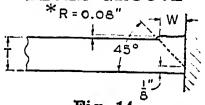


Fig. 14
If underside of weld is chipped or burned out and welded, add 0.19 lb. to steel required (equivalent to approx. 0.27 lb. thinly coated or 0.34 lb. of heavily coated electrodes).

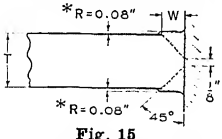
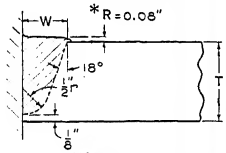
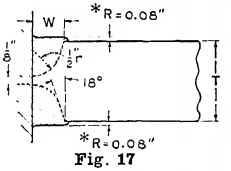


Fig. 15
If underside of top weld is chipped or burned out and welded, add 0.19 lb. to steel required (equivalent to approx. 0.27 lb. thinly coated or 0.34 lb. of heavily coated electrodes).

ϕ Includes scrap-end and spatter loss as outlined on page 58.
* R = Height of reinforcement.

ELECTRODE REQUIREMENTS FOR VARIOUS TYPES OF WELDS

(MANUAL WELDING)

TYPE OF WELD	Inches		ϕ Weight of Electrodes Required in Pounds per Linear Foot (Approx.)				Amount of Steel Deposited per Linear Foot			
			Without Reinforcement		*With Reinforcement		Without Reinforcement		*With Reinforcement	
	T	W	Bare and Thinly Coated	Heavily Coated	Bare and Thinly Coated	Heavily Coated	Cu. In.	Pounds	Cu. In.	Pounds
"J" GROOVE  Fig. 16 If underside of weld is chipped or burned out and welded, add 0.19 lb. to steel required (equivalent to approx. 0.27 lb. thinly coated or 0.34 lb. of heavily coated electrodes).	1	0.625	....	2.55	....	2.85	5.03	1.43	5.64	1.60
	1 1/4	0.719	....	3.64	....	4.00	7.20	2.04	7.91	2.24
	1 1/2	0.781	....	4.80	....	5.15	9.46	2.69	10.20	2.89
	1 3/4	0.875	....	6.12	....	6.55	12.12	3.43	12.95	3.67
	2	0.969	....	7.40	....	7.87	14.63	4.15	15.60	4.41
	2 1/4	1.031	....	9.00	....	9.42	17.75	5.03	18.35	5.19
	2 1/2	1.094	....	10.60	....	11.10	20.90	5.92	21.95	6.21
	2 3/4	1.188	....	12.30	....	12.92	24.35	6.90	25.55	7.23
	3	1.281	....	14.20	....	14.80	28.10	7.95	29.30	8.29
	3 1/2	1.438	....	18.40	....	19.10	36.30	10.30	37.80	10.70
	4	1.594	....	23.00	....	23.70	45.40	12.90	47.00	13.30
DOUBLE-"J" GROOVE  Fig. 17 If underside of top weld is chipped or burned out and welded, add 0.19 lb. to steel required (equivalent to approx. 0.27 lb. thinly coated or 0.34 lb. of heavily coated electrodes).	1	0.500	....	1.87	....	2.37	3.71	1.05	4.67	1.33
	1 1/4	0.563	....	2.48	....	3.03	4.92	1.39	6.00	1.70
	1 1/2	0.594	....	3.52	....	4.08	6.95	1.97	8.10	2.29
	1 3/4	0.625	....	4.37	....	5.00	8.635	2.45	9.83	2.79
	2	0.656	....	5.47	....	6.11	10.80	3.06	12.06	3.42
	2 1/4	0.688	....	6.55	....	7.21	12.97	3.67	14.29	4.04
	2 1/2	0.750	....	7.65	....	8.38	15.12	4.28	16.68	4.69
	2 3/4	0.781	....	8.85	....	9.60	17.52	4.95	19.00	5.38
	3	0.813	....	10.10	....	10.85	19.82	5.62	21.45	6.08
	3 1/2	0.906	....	12.70	....	13.55	25.05	7.12	26.80	7.58
	4	0.969	....	15.70	....	16.60	31.05	8.78	32.80	9.28

ϕ Includes scrap-end and spatter loss as outlined on page 58.

* R = Height of reinforcement.

Courtesy General Electric Co.

RIVETED JOINTS

As riveting is still a commonly used method for joining metal plates and shapes, certain definite standards and data are of interest on the subject.

The first requirement of riveted joints is that they be strong enough to transfer safely the forces acting on the parts joined. This requirement determines only in a general way the design of the joint, because a number of joints can be designed for any given case, all strong enough, but varying widely in size and spacing of rivets.

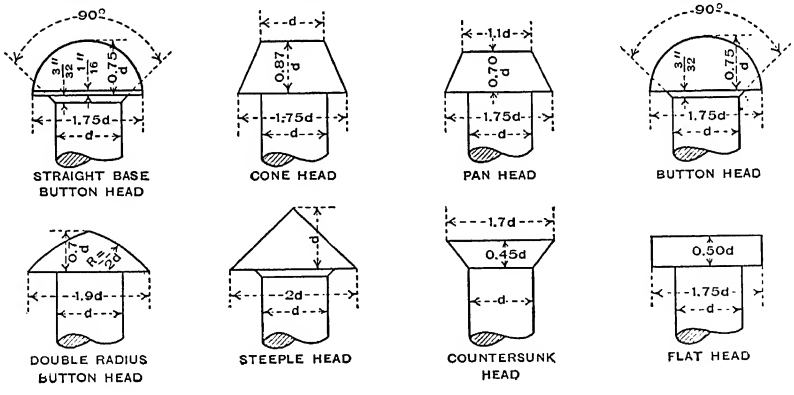
In order to determine the strength of a riveted joint, it is necessary to know the strength of the individual rivets.

Failure of a rivet may occur in either of two ways, by shearing on one or more planes, or by crushing the metal at the point where the rivet bears against the plates or shapes. The load per rivet at which each of these two types of failure may occur is separately calculated and the lower of the two governs the design.

If a large rivet is used on thin metal, the bearing strength usually governs and there is an excess of shear strength. Moreover the pressure required to drive the large rivet frequently causes an undesirable bulging of the thin material around the rivet head. On the other hand, if a small rivet is used in a thick plate, the shear strength is the determining factor and there is an excess of bearing strength.

Proper selection, spacing, driving and caulking of rivets deserve important consideration, and Lancaster Engineers are glad to cooperate at any time on joint design or other required information.

STANDARD PROPORTIONS FOR RIVET HEADS



SHEARING AND BEARING VALUES OF RIVETS IN POUNDS

Size of Rivet, Inch.	Area of Rivet, Square Inch.	UNIT STRESSES, POUNDS PER SQUARE INCH.							
		Shearing	8,000	9,000	10,000	11,000	12,000	13,500	13,500
		Bearing	16,000	18,000	20,000	22,000	24,000	27,000	30,000
3/8	.1104	Single Shear	880	990	1100	1210	1320	1490	1490
		Bearing, Inch. 3/16	1130	1270	1410	1550	1690	1900	2110
		1/4	1500	1690	1880	2060	2250	2530	2810
		Double Shear	1770	1990	2210	2430	2650	2980	2980
1/2	.1963	Single Shear	1570	1770	1960	2160	2360	2650	2650
		Bearing, Inch. 3/16	*1500*	*1690*	*1880*	*2060*	*2250*	*2530*	2810
		1/4	2000	2250	2500	2750	3000	3380	3750
		5/16	2500	2810	3130	3440	3750	4220	4690
		3/8	3000	3380	3750	4130	4500	5060	*5630*
		Double Shear	3140	3530	3930	4320	4710	5300	5300
5/8	.3068	Single Shear	2450	2760	3070	3370	3680	4140	4140
		Bearing, Inch. 3/16	*1880*	*2110*	*2340*	*2580*	*2810*	*3160*	*3520*
		1/4	2500	2810	3130	3440	3750	4220	4690
		5/16	3130	3520	3910	4300	4690	5270	5860
		3/8	3750	4220	4690	5160	5630	6330	7030
		7/16	4380	4920	5470	6020	6560	7380	8200
		Double Shear	4910	5520	6140	6750	7360	8280	8280
3/4	.4418	Single Shear	3530	3980	4420	4860	5300	5960	5960
		Bearing, Inch. 1/4	*3000*	*3380*	*3750*	*4130*	*4500*	*5060*	*5630*
		5/16	3750	4220	4690	5160	5630	6330	7030
		3/8	4500	5060	5630	6190	6750	7590	8440
		7/16	5250	5910	6560	7220	7880	8860	9840
		1/2	6000	6750	7500	8250	9000	10130	11250
		9/16	6750	7590	8440	9280	10130	11390	*12660*
		Double Shear	7070	7950	8840	9720	10600	11930	11930
7/8	.6013	Single Shear	4810	5410	6010	6610	7220	8120	8120
		Bearing, Inch. 1/4	*3500*	*3940*	*4380*	*4810*	*5250*	*5910*	*6560*
		5/16	*4380*	*4920*	*5470*	*6020*	*6560*	*7380*	8200
		3/8	5250	5910	6560	7220	7880	8860	9840
		7/16	6130	6890	7660	8420	9190	10340	11480
		1/2	7000	7880	8750	9630	10500	11810	13130
		9/16	7880	8860	9840	10830	11810	13290	14770
		5/8	8750	9840	10940	12030	13130	14770	*16410*
		11/16	*9630*	*10830*	12030	13230	14440	16240	*18050*
		Double Shear	9620	10820	12030	13230	14430	16240	16240

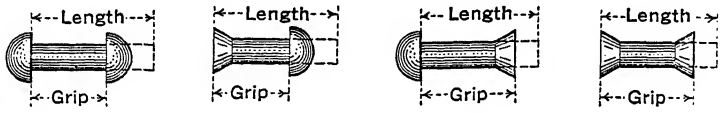
Bearing values given in *italics* are either smaller than single shear or larger than double shear.

SHEARING AND BEARING VALUES OF RIVETS IN POUNDS

Size of Rivet, Inch.	Area of Rivet, Square Inch.	UNIT STRESSES, POUNDS PER SQUARE INCH.						
		Shearing	8,000	9,000	10,000	11,000	12,000	13,500	13,500
		Bearing	16,000	18,000	20,000	22,000	24,000	27,000	30,000
1	.7854	Single Shear							
		Bearing, Inch.							
		1/4							
		5/16							
		3/8	*6000*	*6750*	*7500*				
		7/16	7000	7880	8750				
		1/2	8000	9000	10000				
		9/16	9000	10130	11250				
		5/8	10000	11250	12500				
		11/16	11000	12380	13750				
		3/4	12000	13500	15000				
		Double Shear	12570	14140	15710	17280	18850	21210	21210
1 1/8	.9940	Single Shear	7950	8950	9940	10930	11930	13420	13420
		Bearing, Inch.							
		1/4	*4500*	*5060*	*5630*	*6190*	*6750*	*7590*	*8440*
		5/16	*5630*	*6330*	*7030*	*7730*	*8440*	*9490*	*10550*
		3/8	*6750*	*7590*	*8440*	*9280*	*10130*	*11390*	*12660*
		7/16	*7880*	*8860*	*9840*	*10830*	*11810*	*13290*	14770
		1/2	9000	10130	11250	12380	13500	15190	16880
		9/16	10130	11390	12660	13920	15190	17090	18980
		5/8	11250	12660	14060	15470	16880	18980	21090
		11/16	12380	13920	15470	17020	18560	20880	23200
		3/4	13500	15190	16880	18560	20250	22780	25310
		13/16	14630	16450	18280	20110	21940	24680	*27420*
		7/8	15750	17720	19690	21660	23630	26580	*29530*
		Double Shear	15900	17890	19880	21870	23860	26840	26840
1 1/4	1.2272	Single Shear	9820	11040	12270	13500	14730	16570	16570
		Bearing, Inch.							
		1/4	*5000*	*5630*	*6250*	*6880*	*7500*	*8440*	*9380*
		5/16	*6250*	*7030*	*7810*	*8590*	*9380*	*10550*	*11720*
		3/8	*7500*	*8440*	*9380*	*10310*	*11250*	*12660*	*14060*
		7/16	*8750*	*9840*	*10940*	*12030*	*13130*	*14770*	*16410*
		1/2	10000	11250	12500	13750	15000	16880	18750
		9/16	11250	12660	14060	15470	16880	18980	21090
		5/8	12500	14060	15630	17190	18750	21090	23440
		11/16	13750	15470	17190	18910	20630	23200	25780
		3/4	15000	16880	18750	20630	22500	25310	28130
		13/16	16250	18280	20310	22340	24380	27420	30470
		7/8	17500	19690	21880	24060	26250	29530	32810
		15/16	18750	21090	23440	25780	28130	31640	*35160*
		Double Shear	19640	22090	24540	27000	29450	33130	33130

Bearing values given in *italics* are either smaller than single shear or larger than double shear.

LENGTH OF RIVETS REQUIRED FOR VARIOUS GRIPS, INCLUDING AMOUNT NECESSARY TO FORM ONE HEAD



LENGTHS, IN INCHES, TO FORM BUTTON HEADS.

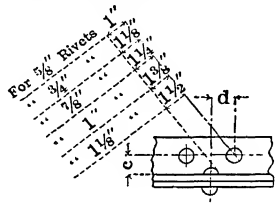
Grip, Inch.	DIAMETER OF RIVET, INCH.							Grip, Inch.	DIAMETER OF RIVET, INCH.				
	½	⅝	¾	⅞	1	1⅛	1¼		¾	⅞	1	1⅛	1¼
1/16	1½	1¾	1⅞	2	2⅛	...	...	4½	6⅜	6½	6½	6⅝	6¾
⅛	1⅝	1⅞	2	2⅛	2¼	...	...	4⅝	6½	6⅝	6⅝	6¾	6⅞
3/16	1¾	2	2⅛	2¼	2⅜	...	...	4¾	6⅝	6¾	6¾	6⅞	7
¼	1⅞	2⅛	2¼	2⅜	2½	...	...	4⅞	6¾	7	7	7	7⅛
1	2	2¼	2⅜	2½	2⅝	2¾	2⅞	5	7	7⅛	7⅛	7¼	7¼
1⅛	2⅛	2⅜	2½	2⅝	2¾	2⅞	3	5⅛	7⅛	7¼	7¼	7⅜	7⅜
1¼	2¼	2½	2⅝	2¾	2⅞	3	3⅛	5¼	7¼	7⅜	7⅜	7½	7½
1⅜	2⅜	2⅝	2¾	2⅞	3	3⅛	3¼	5⅜	7⅜	7½	7½	7⅝	7¾
1½	2½	2¾	2⅞	3	3⅛	3¼	3⅜	5½	7½	7⅝	7⅝	7¾	7⅞
1⅝	2⅝	2⅞	3	3⅛	3¼	3⅜	3½	5⅝	7⅝	7¾	7¾	7⅞	8
1¾	2¾	3	3⅛	3⅜	3⅜	3½	3⅝	5¾	7¾	7⅞	7⅞	8	8⅛
1⅞	2⅞	3⅛	3¼	3½	3½	3⅝	3⅞	5⅞	7⅞	8	8	8⅛	8¼
2	3⅛	3⅜	3½	3⅝	3¾	3⅞	4	6	...	8⅛	8¼	8¼	8⅜
2⅛	3¼	3½	3⅝	3¾	3⅞	4	4⅛	6⅛	...	8¼	8⅜	8⅜	8½
2¼	3⅜	3⅝	3¾	3⅞	4	4⅛	4¼	6¼	...	8⅜	8½	8½	8⅝
2⅜	3½	3¾	3⅞	4	4⅛	4¼	4⅜	6⅜	...	8½	8⅝	8⅝	8¾
2½	3⅝	3⅞	4	4⅛	4¼	4⅜	4½	6½	...	8⅝	8¾	8¾	8⅞
2⅝	3¾	4	4⅛	4¼	4⅜	4½	4⅝	6⅝	...	8¾	8⅞	9	9⅛
2¾	3⅞	4⅛	4¼	4½	4½	4⅝	4¾	6¾	...	8⅞	9	9⅛	9¼
2⅞	4	4⅜	4½	4⅝	4⅝	4¾	4⅞	6⅞	...	9	9⅛	9¼	9⅜
3	4¼	4⅝	4¾	4⅞	4⅞	5	5⅛	7	...	...	9⅜	9⅜	9½
3⅛	4⅜	4¾	4⅞	5	5	5⅛	5¼	7⅛	...	...	9½	9½	9⅝
3¼	4½	4⅞	5	5⅛	5⅛	5¼	5⅜	7¼	...	...	9⅝	9⅝	9¾
3⅜	4⅝	5	5⅛	5¼	5¼	5⅜	5½	7⅜	...	...	9¾	9¾	9⅞
3½	4¾	5⅛	5¼	5⅜	5⅜	5½	5⅝	7½	...	...	9⅞	9⅞	10
3⅝	4⅞	5¼	5⅜	5⅝	5½	5⅝	5¾	7⅝	...	...	10	10	10⅛
3¾	5	5⅜	5½	5¾	5⅝	5¾	5⅞	7¾	...	...	10⅛	10¼	10⅜
3⅞	5⅛	5½	5⅝	5⅞	5¾	5⅞	6	7⅞	...	...	10¼	10⅜	10½
4	...	5¾	5¾	6	6	6⅛	6⅛	8	...	...	....	10½	10⅝
4⅛	...	5⅞	5⅞	6⅛	6⅛	6¼	6¼	8⅛	...	...	....	10⅝	10¾
4¼	..	6	6	6¼	6¼	6⅜	6⅜	8¼	...	...	....	10¾	10⅞
4⅜	...	6⅛	6¼	6⅜	6⅜	6½	6⅝	8⅜	...	...	....	10⅞	11

Amount in Inches to be subtracted from above Lengths to form Countersunk Heads.

½	½	⅝	¾	⅞	1	1⅛		⅝	¾	⅞	1	1⅛

RIVET SPACING

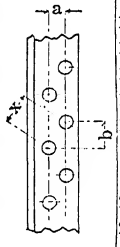
MINIMUM STAGGER FOR RIVETS



Diameter of Rivet, Inches	Minimum stagger, d, inches																
	c, inches																
	1⅛	1³⁄₁₆	1¼	1⁵⁄₁₆	1⅜	1⁷⁄₁₆	1½	1⁹⁄₁₆	1⅝	1¹¹⁄₁₆	1¾	1¹³⁄₁₆	1⅞	1¹⁵⁄₁₆	2¹⁄₁₆	2³⁄₁₆	2⅛
⅝	¹⁵⁄₁₆	⅞	1³⁄₁₆	1¹⁄₁₆	½	⁹⁄₁₆	0										
¾	1¼	1³⁄₁₆	1⅛	1¹⁄₁₆	¹⁵⁄₁₆	⅞	¾	⁹⁄₁₆	⅜	0							
⅞	1½	1⁷⁄₁₆	1⅜	1⁵⁄₁₆	1¼	1³⁄₁₆	1⅛	1	1⁵⁄₁₆	1³⁄₁₆	⅝	⅞	0				
1	1¹³⁄₁₆	1¾	1¹¹⁄₁₆	1⅝	1⁹⁄₁₆	1½	1⁷⁄₁₆	1⅜	1⁵⁄₁₆	1³⁄₁₆	1⅛	1	⅞	¾	0		
1⅛	2¹⁄₁₆	2	1¹⁵⁄₁₆	1¹⁵⁄₁₆	1⅞	1¹³⁄₁₆	1¾	1¹¹⁄₁₆	1⅝	1⁹⁄₁₆	1½	1⅜	1⁵⁄₁₆	1¼	1	1¹⁄₁₆	0

DISTANCE CENTER TO CENTER OF STAGGERED RIVETS

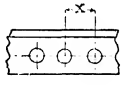
Values of x for varying values of a and b



b, In.	a, Inches												
	⅞	1	1⅛	1¼	1⅜	1½	1⅝	1¾	1⅞	2	2⅛	2¼	2⅜	2½
1⅛	1⁷⁄₁₆	1½	1⁹⁄₁₆	1¹¹⁄₁₆	1¾	1⅞	2	2¹⁄₁₆	2³⁄₁₆	2⁵⁄₁₆	2⅜	2½	2⅝	2¾
1¼	1⁹⁄₁₆	1⅝	1¹¹⁄₁₆	1¾	1⅞	1¹⁵⁄₁₆	2¹⁄₁₆	2⅛	2¼	2⅜	2⁷⁄₁₆	2⁹⁄₁₆	2¹¹⁄₁₆	2¹³⁄₁₆
1⅜	1⅝	1¹¹⁄₁₆	1¾	1⅞	1¹⁵⁄₁₆	2	2¼	2³⁄₁₆	2⅝	2⁷⁄₁₆	2½	2⅝	2¾	2⅞
1½	1¾	1¹³⁄₁₆	1⅞	1¹⁵⁄₁₆	2	2⅛	2³⁄₁₆	2⁵⁄₁₆	2⅜	2½	2⅝	2¹¹⁄₁₆	2¹³⁄₁₆	2¹⁵⁄₁₆
1⅝	1⅞	1⅞	2	2¹⁄₁₆	2⅛	2³⁄₁₆	2⁵⁄₁₆	2⅜	2½	2⁹⁄₁₆	2¹¹⁄₁₆	2¾	2⅞	3
1¾	1¹⁵⁄₁₆	2	2¹⁄₁₆	2¼	2³⁄₁₆	2⁵⁄₁₆	2⅜	2⁷⁄₁₆	2⁹⁄₁₆	2⅝	2¾	2⅞	2¹⁵⁄₁₆	3¹⁄₁₆
1⅞	2¹⁄₁₆	2⅛	2³⁄₁₆	2¼	2⁵⁄₁₆	2⅜	2½	2⁹⁄₁₆	2⅝	2¾	2¹³⁄₁₆	2¹⁵⁄₁₆	3	3⅛
2	2³⁄₁₆	2¼	2⁵⁄₁₆	2⅜	2⁷⁄₁₆	2½	2⁹⁄₁₆	2⅝	2¾	2¹³⁄₁₆	2¹⁵⁄₁₆	3	3⅛	3³⁄₁₆
2⅛	2⁵⁄₁₆	2⁵⁄₁₆	2⅜	2⁷⁄₁₆	2½	2⅝	2¹¹⁄₁₆	2¾	2¹³⁄₁₆	2¹⁵⁄₁₆	3	3¹⁄₁₆	3³⁄₁₆	3¼
2¼	2⁷⁄₁₆	2⁷⁄₁₆	2½	2⁹⁄₁₆	2⅝	2¹¹⁄₁₆	2¾	2⅞	2¹⁵⁄₁₆	3	3¹⁄₁₆	3³⁄₁₆	3¼	3⅜
2⅜	2½	2⁹⁄₁₆	2⅝	2¹¹⁄₁₆	2¾	2¹³⁄₁₆	2⅞	2¹⁵⁄₁₆	3	3⅛	3³⁄₁₆	3¼	3⅜	3⁷⁄₁₆
2½	2⅝	2¹¹⁄₁₆	2¾	2¹³⁄₁₆	2⅞	2¹⁵⁄₁₆	3	3¹⁄₁₆	3⅛	3³⁄₁₆	3¼	3⅜	3⁷⁄₁₆	3⁹⁄₁₆

Values below and to right of upper zigzag line are large enough for ¾" rivets.
Values below and to right of lower zigzag line are large enough for ⅞" rivets.

MINIMUM RIVET SPACING



Dia. of Rivet, Inches	¼	⅜	½	⅝	¾	⅞	1	1⅛
x, Minimum, Inches.	1	1¼	1¾	2	2¼	2⅝	3	3³⁄₈

STEEL RIVETS

Weight in Pounds per 100 Rivets with Button Heads

Length Under Head, Inches	Diameter of Rivet, Inches							
	⅜	½	⅝	¾	⅞	1	1⅛	1¼
1¼	6	12						
⅜	7	13						
½	7	13	23	35	50	68	91	130
⅝	7	14	24	36	52	71	95	134
¾	8	15	25	37	54	74	98	139
⅞	8	15	26	39	56	77	102	143
2	9	16	27	41	58	80	105	148
⅛	9	17	28	43	60	82	109	152
¼	9	18	29	44	62	85	112	156
⅜	10	18	30	46	64	88	116	161
½	10	19	31	47	67	91	119	165
⅝	11	20	32	49	69	93	123	169
¾	11	20	34	50	71	96	126	174
⅞	11	21	35	52	73	99	130	178
3	12	22	36	54	75	102	133	182
⅛	12	22	37	55	77	105	137	187
¼	13	23	38	57	79	107	141	191
⅜	13	24	39	58	81	110	144	195
½	13	24	40	60	84	113	148	200
⅝	14	25	41	61	86	116	151	204
¾	14	26	42	63	88	118	155	208
⅞	15	27	43	64	90	121	158	213
4	15	27	44	66	92	124	162	217
⅛	15	28	45	68	94	127	165	221
¼	16	29	47	69	96	130	169	226
⅜	16	29	48	71	98	132	172	230
½	16	30	49	72	101	135	176	234
⅝	17	31	50	74	103	138	179	239
¾	17	31	51	75	105	141	183	243
⅞	18	32	52	77	107	143	186	247

Length Under Head, Inches	Diameter of Rivet, Inches							
	⅜	½	⅝	¾	⅞	1	1⅛	1¼
5	18	33	53	78	109	146	190	252
⅛	18	34	54	80	111	149	193	256
¼	19	34	55	82	113	152	197	260
⅜	19	35	56	83	115	155	200	265
½	20	36	57	85	118	157	204	269
⅝	20	36	58	86	120	160	207	273
¾	20	37	60	88	122	163	211	278
⅞	21	38	61	89	124	166	214	282
6	21	38	62	91	126	169	218	287
⅛	22	39	63	93	128	171	222	291
¼	22	40	64	94	130	174	225	295
⅜	22	40	65	96	132	177	229	300
½	23	41	66	97	135	180	232	304
⅝	23	42	67	99	137	182	236	308
¾	24	43	68	100	139	185	239	313
⅞	24	43	69	102	141	188	243	317
7	24	44	70	104	143	191	246	321
⅛	25	45	71	105	145	194	250	326
¼	25	45	73	107	147	196	253	330
⅜	26	46	74	108	149	199	257	334
½	26	47	75	110	152	202	260	339
⅝	26	47	76	111	154	205	264	343
¾	27	48	77	113	156	207	267	347
⅞	27	49	78	114	158	210	271	352
8	27	50	79	116	160	213	274	356
⅛	28	50	80	118	162	216	278	360
¼	28	51	81	119	164	219	281	365
⅜	29	52	82	121	166	221	285	369
½	29	52	83	122	169	224	288	373
⅝	29	53	84	124	171	227	292	378
¾	30	54	86	125	173	230	295	382
⅞	30	54	87	127	175	232	299	386

RIVET HEADS

Button Heads	Diameter of Rivets, Inches							
	⅜	½	⅝	¾	⅞	1	1⅛	1¼
100 Heads as made on rivets, Pounds...	2.4	5.0	9.7	16.0	24.0	35.0	49.0	78.0
100 Heads as driven in work, Pounds...	1.9	4.0	7.5	12.5	18.5	27.0	37.5	51.0

REDUCTION OF AREA FOR RIVET HOLES

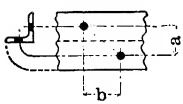
Area in Square Inches=Diameter of Hole by Thickness of Metal

Thickness of Metal, Inches	Diameter of Hole in Inches											
	¼	½	9/16	⅝	11/16	¾	13/16	⅞	15/16	1	1 1/16	1⅛
3/16	.05	.09	.11	.12	.13	.14	.15	.16	.18	.19	.20	.21
¼	.06	.13	.14	.16	.17	.19	.20	.22	.23	.25	.27	.28
5/16	.08	.16	.18	.20	.21	.23	.25	.27	.29	.31	.33	.35
⅜	.09	.19	.21	.23	.26	.28	.30	.33	.35	.38	.40	.42
7/16	.11	.22	.25	.27	.30	.33	.36	.38	.41	.44	.46	.49
½	.13	.25	.28	.31	.34	.38	.41	.44	.47	.50	.53	.56
9/16	.14	.28	.32	.35	.39	.42	.46	.49	.53	.56	.60	.63
⅝	.16	.31	.35	.39	.43	.47	.51	.55	.59	.63	.66	.70
11/16	.17	.34	.39	.43	.47	.52	.56	.60	.64	.69	.73	.77
¾	.19	.38	.42	.47	.52	.56	.61	.66	.70	.75	.80	.84
13/16	.20	.41	.46	.51	.56	.61	.66	.71	.76	.81	.86	.91
⅞	.22	.44	.49	.55	.60	.66	.71	.77	.82	.88	.93	.98
15/16	.23	.47	.53	.59	.64	.70	.76	.82	.88	.94	1.00	1.05
1	.25	.50	.56	.63	.69	.75	.81	.88	.94	1.00	1.06	1.13
1 1/16	.27	.53	.60	.66	.73	.80	.86	.93	1.00	1.06	1.13	1.20
1⅛	.28	.56	.63	.70	.77	.84	.91	.98	1.05	1.13	1.20	1.27
1 3/16	.30	.59	.67	.74	.82	.89	.96	1.04	1.11	1.19	1.26	1.34
1¼	.31	.63	.70	.78	.86	.94	1.02	1.09	1.17	1.25	1.33	1.41
1 5/16	.33	.66	.74	.82	.90	.98	1.07	1.15	1.23	1.31	1.39	1.48
1⅜	.34	.69	.77	.86	.95	1.03	1.12	1.20	1.29	1.38	1.46	1.55
1 7/16	.36	.72	.81	.90	.99	1.08	1.17	1.26	1.35	1.44	1.53	1.62
1½	.38	.75	.84	.94	1.03	1.13	1.22	1.31	1.41	1.50	1.59	1.69

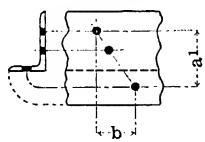
STAGGER OF RIVETS TO MAINTAIN NET SECTION

AMERICAN BRIDGE COMPANY STANDARD

1 Hole Out



2 Holes Out



y=diameter of rivet + ⅛″

$a-y=\sqrt{a^2+b^2}-2y$ $\qquad a^1-2y=\sqrt{a^2+b^2}-3y$

$b=\sqrt{2ay+y^2}$ $\qquad b=\sqrt{2ay+y^2}$

Dimensions in Inches

a	¾″ Rivet b	⅞″ Rivet b	a^1	¾″ Rivet b	⅞″ Rivet b
1	1⅝	1¾	5	3 1/16	3 5/16
1½	1⅞	2	5½	3¼	3½
2	2 1/16	2¼	6	3⅜	3⅝
2½	2¼	2 7/16	6½	3½	3¾
3	2 5/16	2⅝	7	3⅝	3⅞
3½	2 9/16	2 15/16	7½	3¾	4
4	2 13/16	3	8	3⅞	4⅛
4½	2 15/16	3 3/16	8½	4	4¼

a=sum of gages minus thickness of angle.
⅝″ rivets, can be taken at ⅛″ less than for ¾″ rivets.
1″ rivets, can be taken at ⅛″ more than for ⅞″ rivets.

SAFE LOADS FOR U. S. STD. BOLTS

Nominal Diam., In.	No. of Threads per In.	Ultimate Strength, Lb. per Sq. In.						
		20,000	40,000	50,000	60,000	65,000	80,000	95,000
		Alloy Cu, 88% Sn, 10% Zn, 2%	Phosphor-bronze	Wrought Iron and Best Rolled Bronze	Class B Bolt Material	Class A Bolt Material	Class A Nos. 1 and 2 Machinery Forgings	High-grade Machinery Forgings
1/4	20	57	115	143	172	186	229	272
5/16	18	99	198	247	297	322	396	470
3/8	16	150	301	376	451	488	601	714
7/16	14	207	415	519	623	675	830	986
1/2	13	282	564	704	845	915	1,125	1,340
9/16	12	365	730	912	1,095	1,186	1,460	1,730
5/8	11	456	913	1,140	1,370	1,480	1,820	2,170
3/4	10	690	1,380	1,725	2,070	2,240	2,760	3,280
7/8	9	964	1,930	2,410	2,900	3,140	3,860	4,580
1	8	1,265	2,530	3,170	3,800	4,120	5,060	6,010
1 1/8	7	1,595	3,190	3,990	4,790	5,180	6,380	7,570
1 1/4	7	2,070	4,140	5,180	6,210	6,730	8,280	9,830
1 3/8	6	2,440	4,890	6,110	7,330	7,940	9,780	11,600
1 1/2	6	3,020	6,040	7,540	9,060	9,800	12,050	14,300
1 5/8	5 1/2	3,530	7,060	8,820	10,600	11,500	14,100	16,750
1 3/4	5	4,060	8,120	10,150	12,200	13,200	16,200	19,250
1 7/8	5	4,800	9,600	12,000	14,400	15,600	19,200	22,800
2	4 1/2	5,360	10,750	13,400	16,100	17,400	21,500	25,500
2 1/4	4 1/2	7,120	14,200	17,800	21,400	23,100	28,500	33,800
2 1/2	4	8,750	17,500	21,900	26,300	28,400	35,000	41,500
2 3/4	4	11,000	22,000	27,500	33,000	35,700	44,000	52,200
3	4	13,400	26,800	33,500	40,200	43,600	53,600	63,600
3 1/4	4	16,100	32,200	40,200	48,400	52,400	64,400	76,400
3 1/2	4	19,000	38,100	47,600	57,200	61,900	76,200	90,400
3 3/4	4	22,200	44,500	55,600	66,700	72,300	89,000	105,500
4	4	25,700	51,400	64,200	77,000	83,400	102,800	122,000
4 1/4	4	29,350	58,700	73,400	88,100	95,400	117,400	139,300
4 1/2	4	33,300	66,600	83,200	100,000	108,000	133,000	158,000
4 3/4	4	37,400	75,000	93,700	112,000	122,000	150,000	178,000
5	4	41,900	83,800	105,000	126,000	136,000	167,500	199,000
5 1/4	4	46,600	93,200	116,500	140,000	151,000	186,000	221,000
5 1/2	4	51,500	103,000	129,000	154,500	167,000	206,000	244,500
5 3/4	4	56,700	113,500	142,000	170,000	184,000	227,000	269,000
6	4	62,000	124,000	155,000	186,000	202,000	248,000	295,000

STRENGTH OF U. S. STD. BOLTS

Bolt		Areas		Tensile Strength, Lb.			Shearing Strength, Lb.			
							Full Bolt		Bottom of Thread	
Diam. of Bolt, In.	No. of Threads per In.	Full Bolt, Sq. In.	Bottom of Thread, Sq. In.	At 10,000 Lb. per Sq. In.	At 12,500 Lb. per Sq. In.	At 17,500 Lb. per Sq. In.	At 7,500 Lb. per Sq. In.	At 10,000 Lb. per Sq. In.	At 7,500 Lb. per Sq. In.	At 10,000 Lb. per Sq. In.
1/4	20	0.049	0.027	270	340	470	380	490	200	270
5/16	18	0.077	0.045	450	570	790	580	770	340	450
3/8	16	0.110	0.068	680	850	1,190	830	1,100	510	680
7/16	14	0.150	0.093	930	1,170	1,630	1,130	1,500	700	930
1/2	13	0.196	0.126	1,260	1,570	2,200	1,470	1,960	940	1,260
9/16	12	0.248	0.162	1,620	2,030	2,840	1,860	2,480	1,220	1,620
5/8	11	0.307	0.202	2,020	2,520	3,530	2,300	3,070	1,510	2,020
3/4	10	0.442	0.302	3,020	3,770	5,290	3,310	4,420	2,270	3,020
7/8	9	0.601	0.419	4,190	5,240	7,340	4,510	6,010	3,150	4,190
1	8	0.785	0.551	5,510	6,890	9,640	5,890	7,850	4,130	5,510
1 1/8	7	0.994	0.693	6,930	8,660	12,130	7,450	9,940	5,200	6,930
1 1/4	7	1.227	0.890	8,890	11,120	15,570	9,200	12,270	6,670	8,900
1 3/8	6	1.485	1.054	10,540	13,180	18,450	11,140	14,850	7,910	10,540
1 1/2	6	1.767	1.294	12,940	16,170	22,640	13,250	17,670	9,700	12,940
1 5/8	5 1/2	2.074	1.515	15,150	18,940	26,510	15,550	20,740	11,360	15,150
1 3/4	5	2.405	1.745	17,450	21,800	30,520	18,040	24,050	13,080	17,440
1 7/8	5	2.761	2.049	20,490	25,610	35,860	20,710	27,610	15,370	20,490
2	4 1/2	3.142	2.300	23,000	28,750	40,250	23,560	31,420	17,250	23,000
2 1/4	4 1/2	3.976	3.021	30,210	37,770	52,870	29,820	39,760	22,660	30,210
2 1/2	4	4.909	3.716	37,160	46,450	65,040	36,820	49,090	27,870	37,160
2 3/4	4	5.940	4.620	46,200	57,750	80,840	44,580	59,400	34,650	46,200
3	3 1/2	7.069	5.428	54,280	67,850	94,990	53,020	70,690	40,710	54,280

BOLTS—WEIGHTS PER HUNDRED WITH NUTS

Legnth of Bolt	SQUARE HEADS AND NUTS — Diameter of Bolt in Inches									HEXAGON HEADS AND NUTS — Diameter of Bolt in Inches					
	1/4	5/16	3/8	7/16	1/2	5/8	3/4	7/8	1	3/8	1/2	5/8	3/4	7/8	1
1	4	7	11	15	22	37	56	...	...	10	19	33	52	...	...
1 1/4	4	7	11	16	23	39	59	...	...	11	20	34	54	...	...
1 1/2	5	8	12	17	24	41	62	...	...	12	22	36	57	...	...
1 3/4	5	8	13	18	26	43	64	...	...	12	23	38	60	...	...
2	5	9	14	19	27	45	67	101	144	13	24	40	63	93	132
2 1/4	6	9	15	20	28	47	71	104	150	14	26	43	66	97	137
2 1/2	6	10	15	21	30	49	74	109	155	15	27	45	69	101	143
2 3/4	6	10	16	22	31	51	77	113	161	16	29	47	72	105	148
3	7	11	17	24	33	54	80	117	167	16	30	49	75	109	154
3 1/2	7	12	18	25	35	58	86	126	178	18	33	54	82	118	165
4	8	13	20	28	38	62	92	134	189	19	35	58	88	126	176
4 1/2	9	14	21	30	41	66	98	142	198	21	38	62	94	134	186
5	10	15	23	32	43	71	104	151	209	23	41	66	100	143	197
5 1/2	10	16	25	34	46	75	111	159	220	24	44	71	106	151	208
6	11	17	26	36	49	79	117	168	232	26	46	75	112	160	219
6 1/2	...	...	28	38	52	84	123	176	243	27	49	79	119	168	230
7	...	...	29	40	55	88	129	185	254	29	52	84	125	177	241
8	...	...	32	45	60	97	142	202	276	32	58	92	137	194	264
9	...	...	34	49	65	105	154	218	298	35	63	100	149	210	285
10	...	...	...	53	71	114	167	235	320	...	68	109	162	227	307
12	...	...	...	61	82	131	192	269	364	...	80	127	187	261	352
14	...	...	...	...	93	148	217	303	409	...	91	144	212	295	396
1" additional	1.4	2.2	3.1	4.3	5.6	8.7	12.5	17.0	22.3	3.1	5.6	8.7	12.5	17.0	22.3

WEIGHTS OF NUTS, BOLT HEADS AND SHANKS

(For calculating the weight of large bolts)

Diameter of Bolt in Inches	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8	2	2 1/4	2 1/2	2 3/4	3	3 1/2
Wt. of 1 hex. head and 1 hex. nut lb.	1.2	1.7	2.4	2.9	3.6	4.6	5.7	6.8	9.3	13	17.	22.	35
Wt. of 1 sq. head and 1 sq. nut, lb...	1.5	2.0	2.8	3.5	4.4	5.5	6.7	8.1	11.6	15.5	21.	26.	42
Wt. of shank per inch, lb.....	0.28	0.35	0.42	0.5	0.59	0.68	0.78	0.89	1.13	1.40	1.69	2.0	2.7

SQUARE AND HEXAGONAL REGULAR BOLT HEADS

All Dimensions in Inches

Bolt Diameter	Rough and Semi-Finished					Finished				
	Width Across Flats		Min. Width Across Corners		Height	Width Across Flats		Min. Width Across Corners		Height
	Max.	Min.	Hex.	Square		Max.	Min.	Hex.	Square	
1/4	3/8	0.363	0.414	0.498	11/64	7/16	0.428	0.488	0.588	3/16
5/16	1/2	0.484	0.552	0.665	13/64	9/16	0.552	0.629	0.758	15/64
3/8	9/16	0.544	0.620	0.747	1/4	5/8	0.613	0.699	0.842	9/32
7/16	5/8	0.603	0.687	0.828	19/64	3/4	0.737	0.840	1.012	21/64
1/2	3/4	0.725	0.827	0.995	21/64	13/16	0.799	0.911	1.097	3/8
9/16	7/8	0.847	0.966	1.163	3/8	7/8	0.861	0.982	1.182	27/64
5/8	15/64	0.906	1.033	1.244	27/64	15/64	0.922	1.051	1.266	15/32
3/4	1 1/8	1.088	1.240	1.494	1/2	1 1/8	1.108	1.263	1.521	9/16
7/8	1 5/16	1.269	1.447	1.742	19/32	1 5/16	1.293	1.474	1.775	21/32
1	1 1/2	1.450	1.653	1.991	21/32	1 1/2	1.479	1.686	2.031	3/4
1 1/8	1 11/16	1.631	1.859	2.239	3/4	1 11/16	1.665	1.898	2.286	27/32
1 1/4	1 7/8	1.813	2.067	2.489	27/32	1 7/8	1.850	2.109	2.540	15/16
1 1/2	2 1/4	2.175	2.480	2.986	1	2 1/4	2.222	2.533	3.051	1 1/8
1 3/4	2 5/8	2.538	2.893	3.485	1 5/32	2 5/8	2.593	2.956	3.560	1 5/16
2	3	2.900	3.306	3.982	1 11/32	3	2.964	3.379	4.070	1 1/2
2 1/4	3 3/8	3.263	3.720	4.480	1 1/2	3 3/8	3.335	3.802	4.579	1 11/16
2 1/2	3 3/4	3.625	4.133	4.977	1 21/32	3 3/4	3.707	4.226	5.090	1 7/8
2 3/4	4 1/8	3.988	4.546	5.476	1 53/64	4 1/8	4.078	4.649	5.599	2 1/16
3	4 1/2	4.350	4.959	5.973	2	4 1/2	4.449	5.072	6.108	2 1/4

Regular nuts (rough, semi-finished and finished) have a maximum width across flats of 1 1/2D except for D = 1/4 to 9/16 when the width = 1 1/2D + 1/16. D is bolt diameter. Tolerance for width is −.050D. Thickness is 7/8D.

STAYBOLTS

GENERAL INFORMATION ON PRESSURES, SIZES AND PITCH OF STAYBOLTS USED IN CONSTRUCTION OF PRESSURE VESSELS

PRESSURES ON STAY-BOLTED FLAT PLATES, A. S. M. E. BOILER CODE *

Thick In.	Maximum Pitch in Inches																
	4	4 1/2	4 1/4	4 3/8	4 1/2	4 5/8	4 3/4	4 7/8	5	5 1/8	5 1/4	5 3/8	5 1/2	5 5/8	5 3/4	5 7/8	6
1/4	112	105	99	94	89	84	79	75	72	68	65	62	50	57	54	52	50
5/16	175	164	155	146	138	131	124	118	112	106	102	97	93	89	85	81	78
3/8	....	....	223	211	199	188	179	170	161	153	146	139	133	127	122	117	112
7/16	....	....	....	....	....	....	....	231	219	209	199	190	181	173	166	159	152
1/2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	232	223	213

	6 1/8	6 1/4	6 3/8	6 1/2	6 5/8	6 3/4	6 7/8	7	7 1/8	7 1/4	7 3/8	7 1/4	7 5/8	7 3/4	7 7/8	8
1/4	48	46	44	42	41	39	38	37	35	34	33	32	31	30	29	28
5/16	75	72	69	66	64	61	59	57	55	53	51	50	48	47	45	43
3/8	107	103	99	95	92	88	85	82	79	77	74	72	69	67	65	63
7/16	146	140	135	130	125	120	116	112	108	104	101	98	94	91	88	85
1/2	205	197	189	182	179	168	162	157	151	146	141	136	132	128	124	120
9/16	....	....	....	230	221	213	205	198	191	185	179	173	167	162	156	152
5/8	....	....	....	....	....	....	....	....	237	228	221	213	207	200	193	188

*Calculated from A. S. M. E. Boiler Code Rule $p = 112 \times t^2/p^2$, for Plates up to and including 7/16-in. thick. The following formula is to be used only for Plates over 7/16-in. thick. $p = 120 \times t^2/p^2$. Use 7500 lbs. per sq. in. stress on Stay-bolts.

MAXIMUM ALLOWABLE PITCH, IN INCHES, OF SCREWED STAYBOLTS, ENDS RIVETED OVER

Pressure Lb. per Sq. In.	Thickness of Plate, In.						
	5/16	3/8	7/16	1/2	9/16	5/8	11/16
	Maximum Pitch of Staybolts, In.						
100	5 1/4	6 3/8	7 3/8	...	...	...	...
110	5	6	7	8 3/8	...	...	...
120	4 3/4	5 3/4	6 3/4	8	...	...	...
125	4 3/4	5 5/8	6 5/8	7 3/4	...	...	...
130	4 5/8	5 1/2	6 1/2	7 5/8	...	...	...
140	4 1/2	5 3/8	6 1/4	7 3/8	8 3/8	...	...
150	4 1/4	5 1/8	6	7 1/8	8	...	...
160	4 1/8	5	5 7/8	6 7/8	7 3/4	...	...
170	4	4 7/8	5 5/8	6 3/4	7 1/2	8 3/8	...
180	...	4 3/4	5 1/2	6 1/2	7 3/8	8 1/2	...
190	...	4 5/8	5 3/8	6 3/8	7 1/8	7 7/8	...
200	...	4 1/2	5 1/4	6 1/8	7	7 3/4	8 1/2
225	...	4 1/4	4 7/8	5 7/8	6 1/2	7 1/4	8
250	...	4	4 5/8	5 1/2	6 1/4	6 7/8	7 5/8
300	...	...	4 1/4	5	5 5/8	6 1/4	7

SOLID STAYBOLTS

Nominal Size	U. S. Std. Threads 12 Threads per Inch		Whitworth Threads 12 Threads per Inch		Modern or Sharp "V" Threads 12 Threads per Inch	
	Root Dia. in Inches	Root Area in Sq. In.	Root Dia. in Inches	Root Area in Sq. In.	Root Dia. in Inches	Root Area in Sq. In.
3/4"	.6418	.3235	.6432	.3249	.625	.3068
13/16"	.7043	.3895	.7057	.3911	.6875	.3712
7/8"	.7668	.4618	.7682	.4634	.75	.4417
15/16"	.8293	.5401	.8307	.5420	.8125	.5184
1"	.8918	.6246	.8932	.6266	.875	.6013
1 1/16"	.9543	.7152	.9557	.7173	.9375	.6902
1 1/8"	1.0168	.8120	1.0182	.8142	1.000	.7854
1 3/16"	1.0793	.9149	1.0807	.9172	1.0625	.8866
1 1/4"	1.1418	1.0239	1.1432	1.0264	1.125	.9940
1 5/16"	1.2043	1.1390	1.2057	1.1417	1.1875	1.1075
1 3/8"	1.2668	1.2604	1.2682	1.2631	1.250	1.2272
1 7/16"	1.3293	1.3878	1.3307	1.3907	1.3125	1.3530
1 1/2"	1.3918	1.5214	1.3932	1.5244	1.3750	1.4849

STANDARD EXTRAS ON STEEL PLATES

Extras Per 100 Pounds

PLATES are defined as follows:
Over 6" in width and ¼" (10.2 Lb. per Sq. Ft.) or over in thickness.
Over 48" in width and 3/16" (7.65 Lb. per Sq. Ft.) or over in thickness.

THICKNESS EXTRAS

When Ordered to Thickness in Inches

The edge thickness of the plate is always implied.

2" to ¼", inclusive ..... Base
Under ¼" to, and including, 3/16" $0.20

When Ordered to Specified Weight

The average weight in pounds per square foot is always implied.

Specified Weight, Pounds per Square Foot	Specified Width, Inches		
	Over 6 to 48 Inclusive	Over 48 to 72 Inclusive	Over 72
7.65	Strip or Sheets	$0.20 .20	$0.30 .20
Over 7.65 to 10.2, exclusive	Base	Base	.20
10.2 to 11.0, exclusive	Base	Base	Base
11.0 to 81.6, inclusive	Base	Base	Base

WIDTH OR DIAMETER EXTRAS

Specified Width or Diameter, Inches	Specified Thickness or Weight	
	Under ¼", or Under 11 Pounds	¼" or over, or 11 Pounds or Over
Over 72 to 84, inclusive	$0.10	Base
Over 84 to 96, inclusive	.20	Base
Over 96 to 100, inclusive	.30	Base
Over 100 to 110, inclusive	.40	$0.05
Over 110 to 115, inclusive	.45	.10
Over 115 to 120, inclusive	.....	.15
Over 120 to 125, inclusive	.....	.25
Over 125 to 130, inclusive	.....	.50
Over 130 to 140, inclusive	.....	.75
Over 140 to 155, inclusive	.....	1.00
Over 155 to 170, inclusive	.....	1.25
Over 170 to 185, inclusive	.....	1.50
Over 185 to 195, inclusive	.....	2.00

LENGTH OR DIAMETER EXTRAS

Dimensions in Feet

Under 1 ..... $1.55
1 to 2, exclusive ..... .50
2 to 3, exclusive ..... .25
3 to 80, inclusive ..... Base
Over 80 to 90, inclusive ..... .10
Over 90 and to 100, inclusive ..... .15
Over 100 feet: $0.15, plus $0.05 for every additional 5 feet or fraction thereof.

Length or diameter extras apply on plates up to 2" inclusive in thickness, when sheared, and on all thicknesses when flame cut.

STANDARD EXTRAS ON STEEL PLATES

Extras Per 100 Pounds

QUANTITY EXTRAS

The following quantity extras are applicable to total theoretical weight of plates on an order placed for shipment at one time, to one destination:

Under 6,000 lbs. to 4,000 lbs., inclusive $0.25
Under 4,000 lbs. to 2,000 lbs., inclusive ..... .75
Under 2,000 lbs. 1.25

CIRCULAR AND SKETCH PLATE EXTRAS

Not Requiring Re-entrant Cutting

REGULAR SKETCH PLATES (with not more than four straight edges) including straight tapered plates, except as shown below * $0.20

* STRAIGHT TAPERED PLATES with difference in width between ends less than 2", in length of 20' 0" or over ..... No Sketch extra

IRREGULAR SKETCH PLATES (with more than four straight edges) ... .50

CIRCULAR PLATES ..... .50

SEMI-CIRCULAR AND SKETCH PLATES furnished to a radius ..... .50

All circular and sketch plates are invoiced at actual weight, and are subject to weight tolerances 25% in excess of those applying to rectangular plates.

EXCESS STAMPING EXTRA

For amount of stamping specified for flange or higher classifications, except Marine Steel, greater than required in A. S. T. M. or A. S. M. E. Boiler Plate Specifications ..... .05

SPECIAL DISCARD EXTRA

For specified amount of discard not to exceed 50% ..... .40

THICKNESS LIMITS FOR SHEARING

	Maximum Thickness Limits for Shearing	
Maximum Carbon Specified	Circular Plates	Rectangular Plates
.30% and under	1¼"	2"
.31% to .40%, inclusive	1"	2"
.41% to .50%, inclusive	¾"	1½"
.51% to .60%, inclusive	⅝"	1¼"

Plates outside the limits in the above table must be flame cut, for which the regular flame cutting extras apply.

STANDARD EXTRAS ON STEEL PLATES

Extras Per 100 Pounds

QUALITY EXTRAS

Hot pressing steel (not flange boiler steel)	$0.10
Plates to stand cold pressing or cold flanging	.15
Drawing quality steel, maximum carbon not over .20%	.25
(*) Flange boiler steel A. S. T. M. A70 or equivalent	.15
(*) Ordinary firebox steel A. S. T. M. A70 or equivalent	.20
Locomotive firebox steel	.50
Marine steel	1.50
Stillbottom steel	.30

SPECIFICATION EXTRAS

The following extras applicable to specifications listed under this heading or to equivalent specifications include Quality, Chemical, and Special Requirement extras, but no other extras.

Structural quality plates A. S. T. M. Specification A78-33	.05
Structural silicon steel—A. S. T. M. Specification A94:	
Plates 36″ or under in width	.50
Plates over 36″ in width	.75

U. S. NAVY SPECIFICATIONS 48-S-5	Up to 1″ Thick, Inc.	Over 1″ Thick
Welding quality (Par. H3)		
Soft	$0.25	$0.25
Medium	.50	.75
High Tensile	3.10	3.10
Ordinary quality (Par. H3)		
Soft	.25	.25
Medium	.25	.25
High Tensile	1.00	1.00

Boiler steel U. S. Navy Spec. 48-P-2 Classes A and B	1.50
High tensile strength for pressure vessels A. S. T. M. Spec. A149-36 (flange quality) 2″ or under, thick	.90
High tensile strength for pressure vessels A. S. T. M. Spec. A149-36 (firebox quality) 2″ or under, thick	.95
(*) High tensile strength for fusion welded pressure vessels, A. S. T. M. specification A-150-36 or A. S. M. E. S-27 (firebox quality, grades A and B). Includes thickness extra for plates of 2″ to 4″ thick	1.20

(*) When these specifications require any material to be normalized or annealed, the extra shown under Heat Treatment shall apply in addition to Specification Extra.

STANDARD EXTRAS ON STEEL PLATES

Extras Per 100 Pounds

PICKLING, SAND BLASTING AND OILING EXTRAS

For pickling or sand blasting plates over 6" to 24" wide, exclusive, 5/8" or under in thickness (includes oiling or liming) $0.25

For pickling or sand blasting plates 24" wide and over, 5/8" or under in thickness (not including oiling) ..... .15

For oiling plates—all sizes, 24" and over ..... .10

PICKLING OR SAND BLASTING BY PURCHASER

For plates of each quality classification subject to surface inspection and rejection after pickling or sand blasting ..... .15

When plates are to be pickled or sand blasted by the purchaser, and the above extra has not been added to the regular quality extra, the material shall be accepted before pickling or sand blasting.

HEAT TREATMENT EXTRAS

Stress relieving for correcting rolling or cutting stresses:

Plates 5/8" thick, or under, up to .30 carbon ..... .15

Plates 5/8" thick, or under, .30 to .60 carbon, inclusive ..... .25

Plates 5/8" thick, or under, over .60 carbon ..... .50

Plates over 5/8" thick ..... .50

Normalizing or annealing, all thicknesses ..... .50

NORMALIZING TEST PIECES

For stress relieving test specimens for material of lower classification than Locomotive Firebox Quality (extra charged on weight of plates represented by test pieces) ..... .05

Locomotive Firebox Quality or higher classifications, no extra.

INSPECTION EXTRAS

Customary mill practice within the intent of A. S. T. M. Standard Specifications ..... Base

Inspection by commercial inspection companies, American Bureau of Shipping, Lloyd's or others and payment of their charges shall be arranged direct with them by the purchaser. This rule does not apply to the special arrangements with the United States Navy Department for payment for check analysis occasionally made at commercial laboratories.

EXTRAS FOR SPECIFIED DIMENSIONAL AND WORKMANSHIP TOLERANCES DIFFERENT FROM MANUFACTURERS' STANDARDS

Thickness or weight tolerances closer than standard ..... .15

Width, U. M. Plates, tolerances closer than standard ..... .15

Shearing tolerances closer than standard ..... .15

Camber tolerances closer than standard ..... .15

Flatness tolerances closer than standard ..... .15

CHEMICAL REQUIREMENT EXTRAS

Physical tests will not be furnished on plates ordered to chemical requirements only.

STANDARD EXTRAS ON STEEL PLATES

Extras Per 100 Pounds

CARBON

The mean of the specified range shall determine the extra. When the purchaser allows an actual and unqualified working range greater than the Manufacturers' Standard range, the mean of the lowest Standard range, within such greater permissible range, shall determine the extra.

	Widths	
	6 1/16" to 36"	Over 36"
.10% to .25%, inclusive	Base	Base
Over .25% to .40%, inclusive	$0.10	$0.10
Over .40% to .60%, inclusive	.15	.25
Over .60% to .90%, inclusive	.20	.40
Over .90% to 1.25%, inclusive	.50	.75

MANGANESE

The mean of the specified range shall determine the extra. When the purchaser allows an actual and unqualified working range greater than the Manufacturers' Standard range, the mean of the lowest Standard range, within such greater permissible range, shall determine the extra, but in no case shall the maximum of such working range be over 1.65%.

.30% to .70%, inclusive	Base
Over .70% to .90%, inclusive	$0.10
Over .90% to 1.15%, inclusive	.20
Over 1.15% to 1.35%, inclusive, max. carbon .20% or over	.40
Over 1.15% to 1.35%, inclusive, max. carbon under .20%	.65

SILICON

Silicon Specified, per cent	Width, Inches	
	36 or Under	Over 36
Maximum, over .10 to .25, incl. (*)	$0.25	$0.25
over .26 to .50, incl.	.35	.60
Minimum, .14 or under (*)	.25	.25
.15 to .30, incl.	.35	.60
Silicon killed steel (*)	.25	.25

(*) These extras do not apply to forging quality, guaranteed case carburizing quality, or to any plates over 2" thick which are subject to physical test requirements.

PHOSPHORUS

Any specified minimum up to .08%, inclusive $0.05

SULPHUR

Any specified minimum up to .10%, inclusive	.10
.11% to .20% minimum, inclusive	.175
.21% to .30% minimum, inclusive	.25

COPPER

When copper bearing steel is specified; or for any specified minimum up to and including .20%	.10

STANDARD EXTRAS ON STEEL PLATES

Extras Per 100 Pounds

MAXIMUM PHYSICAL SPECIFICATIONS

When the maximum tensile strength of plain carbon structural steel is specified in excess of 72,000 pounds per square inch, extras for the required carbon content will apply.

RESTRICTED PHYSICAL TEST REQUIREMENT EXTRAS

TENSILE RANGES specified less than 10,000 lbs., but not less than 8,000 lbs., within a maximum limit of 72,000 lbs., per sq. in. $0.10

YIELD POINT with specified minimum greater in proportion to the tensile strength than required by A. S. T. M. specifications for similar classes of material ..... .10

DUCTILITY (includes bend test) specified greater in proportion than required by A. S. T. M. specifications for similar class and grade of material ..... .10

TESTING EXTRAS

Tank or structural steel to test requirements not more restrictive than the latest issue of A. S. T. M. standard or tentative standard specifications or A. A. S. M. T. C. standard specifications (carbon steel only) or equivalent specifications ..... Base

When the number of physical tests specified for each plate as rolled exceeds those called for in A. S. T. M. specifications for flange or firebox classifications; or kinds of tests other than herein provided for are specified; for each additional test ..... .10

When the number of tension and bend tests specified for structural classifications exceed two per melt or unit of 50 tons ..... .10

When physical tests other than tension and bend are specified for structural classifications tested by melt units ..... .10

For tests from each plate ordered as distinguished from each plate rolled ..... .25

Extensometer tests for determination of yield strength (set method), elastic limit, proportional limit, or other elastic properties requiring stress strain diagram or equivalent ..... .25

SPECIAL TEST EXTRAS

Segregation test (other than check analysis and homogeneity tests covered in A. S. T. M. and A. S. M. E. Boiler Plate specifications) involving check analysis or fracture tests from top of plate ..... .25

Tension tests from top of plate, i.e., other than at the side according to standard practice under A. S. T. M. or A. S. M. E. specifications ..... .25

Etch test (macroscopic only) ..... .25

Note: The foregoing extras for segregation, homogeneity, fracture, tension and etch tests apply to Firebox or higher quality classifications. Any of these special tests change a lower classification to Firebox quality and the respective extras shall be added to that for Firebox quality.

OVERWEIGHTS

TABLE FOR USE BY ESTIMATORS IN CALCULATING APPROXIMATE AVERAGE PLATE OVERWEIGHTS

HALF THE ALLOWABLE OVERWEIGHT ON STEEL PLATES ORDERED TO THICKNESS

3/16″ to 53/64″ Inclusive

	Theoretical Weight	Under 48″	48 to 60 in., excl.	60 to 72 in., excl.	72 to 84 in., excl.	84 to 96 in., excl.	96 to 108 in., excl.	108 to 120 in., excl.	120 to 132 in. excl.
3/16″	7.65	7.92	7.96	7.99	8.03	8.11			
7/32″	8.925	9.24	9.28	9.33	9.37	9.46			
1/4″	10.2	10.5	10.56	10.61	10.66	10.71	10.81	10.91	11.02
5/16″	12.75	13.07	13.13	13.2	13.26	13.32	13.39	13.52	13.64
21/64″	13.387	13.72	13.79	13.86	13.92	13.99	14.06	14.19	14.32
11/32″	14.025	14.38	14.45	14.52	14.59	14.66	14.73	14.87	15.01
23/64″	14.662	15.03	15.10	15.18	15.25	15.32	15.40	15.54	15.69
3/8″	15.3	15.64	15.68	15.76	15.84	15.91	15.99	16.07	16.22
25/64″	15.937	16.3	16.34	16.42	16.49	16.57	16.65	16.73	16.89
13/32″	16.575	16.95	16.99	17.07	17.16	17.24	17.32	17.40	17.57
27/64″	17.212	17.6	17.64	17.73	17.81	17.9	17.99	18.07	18.24
7/16″	17.85	18.21	18.25	18.3	18.39	18.47	18.56	18.65	18.74
29/64″	18.487	18.86	18.9	18.95	19.04	19.13	19.23	19.32	19.41
15/32″	19.125	19.51	19.56	19.60	19.7	19.79	19.89	19.99	20.08
31/64″	19.762	20.16	20.21	20.26	20.35	20.45	20.55	20.65	20.75
1/2″	20.4	20.76	20.81	20.86	20.91	21.01	21.11	21.22	21.32
33/64″	21.037	21.41	21.46	21.51	21.56	21.67	21.77	21.88	21.98
17/32″	21.675	22.05	22.11	22.16	22.22	22.33	22.43	22.54	22.65
35/64″	22.312	22.70	22.76	22.81	22.87	22.98	23.09	23.20	23.32
9/16″	22.95	23.35	23.41	23.47	23.52	23.64	23.75	23.87	23.98
37/64″	23.587	24.0	24.06	24.12	24.18	24.29	24.41	24.53	24.65
19/32″	24.225	24.65	24.71	24.77	24.83	24.95	25.07	25.19	25.32
39/64″	24.862	25.3	25.36	25.42	25.48	25.61	25.73	25.86	25.98
5/8″	25.5	25.88	25.95	26.01	26.07	26.14	26.27	26.39	26.52
41/64″	26.137	26.53	26.59	26.66	26.73	26.79	26.92	27.05	27.18
21/32″	26.775	27.18	27.24	27.31	27.38	27.44	27.58	27.71	27.85
43/64″	27.412	27.82	27.89	27.96	28.03	28.1	28.23	28.37	28.51
11/16″	28.05	28.47	28.54	28.61	28.68	28.75	28.89	29.03	29.17
45/64″	28.687	29.12	29.19	29.26	29.33	29.40	29.55	29.69	29.83
23/32″	29.325	29.76	29.84	29.91	29.98	30.06	30.20	30.35	30.5
47/64″	29.962	30.41	30.49	30.56	30.64	30.71	30.86	31.01	31.16
3/4″	30.6	30.98	31.06	31.14	31.21	31.29	31.37	31.52	31.67
49/64″	31.237	31.63	31.71	31.78	31.86	31.94	32.02	32.17	32.33
25/32″	31.875	32.27	32.35	32.43	32.51	32.59	32.67	32.83	32.99
51/64″	32.512	32.92	33.0	33.08	33.16	33.24	33.32	33.49	33.65
13/16″	33.150	33.56	33.65	33.73	33.81	33.9	33.98	34.14	34.31
53/64″	33.787	34.21	34.29	34.38	34.46	34.55	34.63	34.80	34.97

OVERWEIGHTS

TABLE FOR USE BY ESTIMATORS IN CALCULATING APPROXIMATE AVERAGE PLATE OVERWEIGHTS

HALF THE ALLOWABLE OVERWEIGHT ON STEEL PLATES ORDERED TO THICKNESS

$2\frac{7}{32}$" to $1\frac{13}{32}$" Inclusive

	Theoretical Weight	Under 48"	48 to 60 in., excl.	60 to 72 in., excl.	72 to 84 in., excl.	84 to 96 in., excl.	96 to 108 in., excl.	108 to 120 in., excl.	120 to 132 in., excl.
$2\frac{7}{32}$"	34.425	34.86	34.94	35.03	35.11	35.2	35.29	35.46	35.63
$5\frac{5}{64}$"	35.062	35.5	35.59	35.68	35.76	35.85	35.94	36.11	36.29
$\frac{7}{8}$"	35.7	36.15	36.24	36.32	36.41	36.5	36.59	36.77	36.95
$5\frac{7}{64}$"	36.337	36.79	36.88	36.97	37.06	37.15	37.25	37.43	37.61
$2\frac{9}{32}$"	36.975	37.44	37.53	37.62	37.71	37.81	37.9	38.08	38.27
$5\frac{9}{64}$"	37.612	38.08	38.18	38.27	38.36	38.46	38.55	38.74	38.93
$1\frac{5}{16}$"	38.25	38.73	38.82	38.92	39.02	39.11	39.21	39.4	39.59
$6\frac{1}{64}$"	38.887	39.37	39.47	39.57	39.66	39.76	39.86	40.05	40.25
$3\frac{1}{32}$"	39.525	40.02	40.12	40.22	40.32	40.41	40.51	40.71	40.91
$6\frac{3}{64}$"	40.162	40.66	40.76	40.86	40.97	41.07	41.17	41.37	41.57
1"	40.8	41.31	41.31	41.41	41.51	41.62	41.72	41.82	42.02
$1\frac{1}{64}$"	41.437	41.95	41.95	42.06	42.16	42.27	42.37	42.47	42.68
$1\frac{1}{32}$"	42.075	42.6	42.6	42.71	42.81	42.92	43.02	43.13	43.34
$1\frac{3}{64}$"	42.712	43.25	43.25	43.35	43.46	43.57	43.67	43.78	43.99
$1\frac{1}{16}$"	43.35	43.89	43.89	44.0	44.11	44.22	44.33	44.43	44.65
$1\frac{5}{64}$"	43.987	44.54	44.54	44.65	44.76	44.87	44.98	45.09	45.31
$1\frac{3}{32}$"	44.625	45.18	45.18	45.29	45.41	45.52	45.63	45.74	45.96
$1\frac{7}{64}$"	45.262	45.83	45.83	45.94	46.05	46.17	46.28	46.39	46.62
$1\frac{1}{8}$"	45.9	46.47	46.47	46.59	46.7	46.82	46.93	47.05	47.28
$1\frac{9}{64}$"	46.537	47.12	47.12	47.24	47.35	47.47	47.58	47.7	47.93
$1\frac{5}{32}$"	47.175	47.76	47.76	47.88	48.0	48.12	48.24	48.35	48.59
$1\frac{11}{64}$"	47.812	48.41	48.41	48.53	48.65	48.77	48.89	49.01	49.25
$1\frac{3}{16}$"	48.45	49.06	49.06	49.18	49.30	49.42	49.54	49.66	49.90
$1\frac{13}{64}$"	49.087	49.70	49.70	49.82	49.95	50.07	50.19	50.31	50.56
$1\frac{7}{32}$"	49.725	50.35	50.35	50.47	50.60	50.72	50.84	50.97	51.22
$1\frac{15}{64}$"	50.362	50.99	50.99	51.12	51.24	51.37	51.50	51.62	51.87
$1\frac{1}{4}$"	51.00	51.64	51.64	51.77	51.89	52.02	52.15	52.28	52.53
$1\frac{17}{64}$"	51.637	52.28	52.28	52.41	52.54	52.67	52.80	52.93	53.19
$1\frac{9}{32}$"	52.275	52.93	52.93	53.06	53.19	53.32	53.45	53.58	53.84
$1\frac{19}{64}$"	52.912	53.57	53.57	53.71	53.84	53.97	54.10	54.24	54.50
$1\frac{5}{16}$"	53.55	54.22	54.22	54.35	54.49	54.62	54.75	54.89	55.16
$1\frac{21}{64}$"	54.187	54.86	54.86	55.00	55.14	55.27	55.41	55.54	55.81
$1\frac{11}{32}$"	54.825	55.51	55.51	55.65	55.78	55.92	56.06	56.20	56.47
$1\frac{23}{64}$"	55.462	56.16	56.16	56.29	56.43	56.57	56.71	56.85	57.13
$1\frac{3}{8}$"	56.10	56.80	56.80	56.94	57.08	57.22	57.36	57.50	57.78
$1\frac{25}{64}$"	56.737	57.45	57.45	57.59	57.73	57.87	58.01	58.16	58.44
$1\frac{13}{32}$"	57.375	58.09	58.09	58.23	58.38	58.52	58.67	58.81	59.10

OVERWEIGHTS

TABLE FOR USE BY ESTIMATORS IN CALCULATING APPROXIMATE AVERAGE PLATE OVERWEIGHTS

HALF THE ALLOWABLE OVERWEIGHT ON STEEL PLATES ORDERED TO THICKNESS

1 27/64″ to 2″ Inclusive

	Theo-retical Weight	Under 48″	48 to 60 in., excl.	60 to 72 in., excl.	72 to 84 in., excl.	84 to 96 in., excl.	96 to 108 in., excl.	108 to 120 in., excl.	120 to 132 in., excl.
1 27/64″	58.012	58.74	58.74	58.88	59.03	59.17	59.32	59.46	59.75
1 7/16″	58.65	59.38	59.38	59.53	59.68	59.82	59.97	60.12	60.41
1 29/64″	59.287	60.03	60.03	60.18	60.33	60.47	60.62	60.77	61.07
1 15/32″	59.925	60.67	60.67	60.82	60.97	61.12	61.27	61.42	61.72
1 31/32″	60.562	61.32	61.32	61.47	61.62	61.77	61.93	62.08	62.38
1 1/2″	61.20	61.97	61.97	62.12	62.27	62.42	62.58	62.73	63.04
1 33/64″	61.837	62.61	62.61	62.76	62.92	63.07	63.23	63.38	63.69
1 17/32″	62.475	63.26	63.26	63.41	63.57	63.72	63.88	64.04	64.35
1 35/64″	63.112	63.90	63.90	64.06	64.22	64.37	64.53	64.69	65.01
1 9/16″	63.75	64.55	64.55	64.71	64.87	65.03	65.18	65.34	65.66
1 37/64″	64.387	65.19	65.19	65.35	65.51	65.68	65.84	66.00	66.32
1 19/32″	65.025	65.84	65.84	66.00	66.16	66.33	66.49	66.65	66.98
1 39/64″	65.662	66.48	66.48	66.65	66.82	66.98	67.14	67.30	67.63
1 5/8″	66.30	67.13	67.13	67.29	67.46	67.63	67.79	67.96	68.29
1 41/64″	66.937	67.77	67.77	67.94	68.11	68.28	68.44	68.61	68.95
1 21/32″	67.575	68.42	68.42	68.59	68.76	68.93	69.10	69.26	69.60
1 43/64″	68.212	69.06	69.06	69.24	69.41	69.58	69.75	69.92	70.26
1 11/16″	68.85	69.71	69.71	69.88	70.05	70.23	70.40	70.57	70.92
1 45/64″	69.487	70.36	70.36	70.53	70.70	70.88	71.05	71.22	71.57
1 23/32″	70.125	71.00	71.00	71.18	71.35	71.53	71.70	71.88	72.23
1 47/64″	70.762	71.65	71.65	71.82	72.00	72.18	72.35	72.53	72.89
1 3/4″	71.40	72.29	72.29	72.47	72.65	72.83	73.01	73.19	73.54
1 49/64″	72.037	72.94	72.94	73.12	73.30	73.48	73.66	73.84	74.20
1 25/32″	72.675	73.58	73.58	73.77	73.95	74.13	74.31	74.49	74.86
1 51/64″	73.312	74.23	74.23	74.41	74.60	74.78	74.96	75.15	75.51
1 13/16″	73.95	74.87	74.87	75.06	75.24	75.43	75.61	75.80	76.17
1 53/64″	74.587	75.52	75.52	75.71	75.89	76.08	76.27	76.45	76.83
1 27/32″	75.225	76.17	76.17	76.35	76.54	76.73	76.92	77.11	77.48
1 55/64″	75.862	76.81	76.81	77.00	77.19	77.38	77.57	77.76	78.14
1 7/8″	76.50	77.46	77.46	77.65	77.84	78.03	78.22	78.41	78.80
1 57/64″	77.137	78.10	78.10	78.29	78.49	78.68	78.87	79.07	79.45
1 29/32″	77.775	78.75	78.75	78.94	79.14	79.33	79.52	79.72	80.11
1 59/64″	78.412	79.39	79.39	79.59	79.78	79.98	80.18	80.37	80.76
1 15/16″	79.05	80.04	80.04	80.24	80.43	80.63	80.83	81.03	81.42
1 61/64″	79.687	80.68	80.68	80.88	81.08	81.28	81.48	81.68	82.08
1 31/32″	80.325	81.33	81.33	81.53	81.73	81.93	82.13	82.33	82.73
1 63/64″	80.962	81.97	81.97	82.18	82.38	82.58	82.78	82.99	83.39
2″	81.60	82.62	82.62	82.82	83.03	83.23	83.44	83.64	84.05

PERMISSIBLE VARIATIONS OF PLATES ORDERED TO WEIGHT

Ordered Weight, Lb. per Sq. Ft.	Permissible Variations in Average Weights per Square Foot of Plates for Widths Given, Expressed in Percentages of Ordered Weights																		Ordered Weight, Lb. per Sq. Ft.
	Under 48 in.,		48 to 60 in., excl.		60 to 72 in., excl.		72 to 84 in., excl.		84 to 96 in., excl.		96 to 108 in., excl.		108 to 120 in., excl.		120 to 132 in., excl.		132 in. or over		
	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	
Under 5	5	3	5.5	3	6	3	7	3	...	...	...	...	...	...	...	...	...	...	Under 5
5 to 7.5 excl.	4.5	3	5	3	5.5	3	6	3	...	...	...	...	...	...	...	...	...	...	5 to 7.5 excl.
7.5 to 10 "	4	3	4.5	3	5	3	5.5	3	6	3	7	3	8	3	...	...	...	...	7.5 to 10 "
10 to 12.5 "	3.5	2.5	4	3	4.5	3	5	3	5.5	3	6	3	7	3	8	3	9	3	10 to 12.5 "
12.5 to 15 "	3	2.5	3.5	2.5	4	3	4.5	3	5	3	5.5	3	6	3	7	3	8	3	12.5 to 15 "
15 to 17.5 "	2.5	2.5	3	2.5	3.5	2.5	4	3	4.5	3	5	3	5.5	3	6	3	7	3	15 to 17.5 "
17.5 to 20 "	2.5	2	2.5	2.5	3	2.5	3.5	2.5	4	3	4.5	3	5	3	5.5	3	6	3	17.5 to 20 "
20 to 25 "	2	2	2.5	2	2.5	2.5	3	2.5	3.5	2.5	4	3	4.5	3	5	3	5.5	3	20 to 25 "
25 to 30 "	2	2	2	2	2.5	2	2.5	2.5	3	2.5	3.5	3	4	3	4.5	3	5	3	25 to 30 "
30 to 40 "	2	2	2	2	2	2	2.5	2	2.5	2.5	3	2.5	3.5	3	4	3	4.5	3	30 to 40 "
40 or over	2	2	2	2	2	2	2	2	2.5	2	2.5	2.5	3	2.5	3.5	3	4	3	40 or over

Note.—The weight per square foot of individual plates shall not vary from the ordered weight by more than 1½ times the amount given in this table.

PERMISSIBLE OVERWEIGHTS OF PLATES ORDERED TO THICKNESS

Ordered Thickness, In.	Permissible Excess in Average Weights per Square Foot of Plates for Widths Given, Expressed in Percentages of Nominal Weights									Ordered Thickness, In.
	Under 48 in.	48 to 60 in., excl.	60 to 72 in., excl.	72 to 84 in., excl.	84 to 96 in., excl.	96 to 108 in., excl.	108 to 120 in., excl.	120 to 132 in., excl.	132 in. or over	
Under 1/8	9	10	12	14	.....	.....	..	..	..	Under 1/8
1/8 to 3/16 excl.	8	9	10	12	.....	.....	..	..	..	1/8 to 3/16 excl.
3/16 to 1/4 "	7	8	9	10	12	.....	..	....	..	3/16 to 1/4 "
1/4 to 5/16 "	6	7	8	9	10	12	14	16	19	1/4 to 5/16 "
5/16 to 3/8 "	5	6	7	8	9	10	12	14	17	5/16 to 3/8 "
3/8 to 7/16 "	4.5	5	6	7	8	9	10	12	15	3/8 to 7/16 "
7/16 to 1/2 "	4	4.5	5	6	7	8	9	10	13	7/16 to 1/2 "
1/2 to 5/8 "	3.5	4	4.5	5	6	7	8	9	11	1/2 to 5/8 "
5/8 to 3/4 "	3	3.5	4	4.5	5	6	7	8	9	5/8 to 3/4 "
3/4 to 1 "	2.5	3	3.5	4	4.5	5	6	7	8	3/4 to 1 "
1 or over	2.5	2.5	3	3.5	4	4.5	5	6	7	1 or over

AREAS AND CIRCUMFERENCES OF CIRCLES

Diam.	Area	Circum.	Diam.	Area	Circum.	Diam.	Area	Circum.
1/64	.00019	.04909	2 3/8	4.4301	7.4613	7 7/8	48.707	24.740
1/32	.00077	.09818	7/16	4.6664	7.6576	8.	50.265	25.133
3/64	.00173	.14726	1/2	4.9087	7.8540	1/8	51.849	25.525
1/16	.00307	.19635	9/16	5.1572	8.0503	1/4	53.456	25.918
5/64	.00479	.24544	5/8	5.4119	8.2467	3/8	55.088	26.311
3/32	.00690	.29452	11/16	5.6727	8.4430	1/2	56.745	26.704
7/64	.00939	.34361	3/4	5.9396	8.6394	5/8	58.426	27.096
1/8	.01227	.39270	13/16	6.2126	8.8357	3/4	60.132	27.489
9/32	.01917	.49087	7/8	6.4918	9.0321	7/8	61.862	27.882
5/64	.02761	.58905	15/16	6.7771	9.2284	9.	63.617	28.274
11/32	.03758	.68722	3.	7.0686	9.4248	1/8	65.397	28.667
1/4	.04909	.78540	1/16	7.3662	9.6211	1/4	67.201	29.060
9/32	.06213	.88357	1/8	7.6699	9.8175	3/8	69.029	29.452
5/16	.07670	.98175	3/16	7.9798	10.014	1/2	70.882	29.845
11/32	.09281	1.0799	1/4	8.2958	10.210	5/8	72.760	30.238
3/8	.11045	1.1781	5/16	8.6179	10.407	3/4	74.662	30.631
13/32	.12962	1.2763	3/8	8.9462	10.603	7/8	76.589	31.023
7/16	.15033	1.3744	7/16	9.2806	10.799	10.	78.540	31.416
15/32	.17257	1.4726	1/2	9.6211	10.996	1/8	80.516	31.809
1/2	.19635	1.5708	9/16	9.9678	11.192	1/4	82.516	32.201
17/32	.22166	1.6690	5/8	10.321	11.388	3/8	84.541	32.594
9/16	.24850	1.7671	11/16	10.680	11.585	1/2	86.590	32.987
19/32	.27688	1.8653	3/4	11.045	11.781	5/8	88.664	33.379
5/8	.30680	1.9635	13/16	11.416	11.977	3/4	90.763	33.772
21/32	.33824	2.0617	7/8	11.793	12.174	7/8	92.886	34.165
11/16	.37122	2.1598	15/16	12.177	12.370	11.	95.033	34.558
23/32	.40574	2.2580	4.	12.566	12.566	1/8	97.205	34.950
3/4	.44179	2.3562	1/16	12.962	12.763	1/4	99.402	35.343
25/32	.47937	2.4544	1/8	13.364	12.959	3/8	101.62	35.736
13/16	.51849	2.5525	3/16	13.772	13.155	1/2	103.87	36.128
27/32	.55914	2.6507	1/4	14.186	13.352	5/8	106.14	36.521
7/8	.60132	2.7489	5/16	14.607	13.548	3/4	108.43	36.914
29/32	.64504	2.8471	3/8	15.033	13.744	7/8	110.75	37.306
15/16	.69029	2.9452	7/16	15.466	13.941	12.	113.10	37.699
31/32	.73708	3.0434	1/2	15.904	14.137	1/8	115.47	38.092
1.	.7854	3.1416	9/16	16.349	14.334	1/4	117.86	38.485
1/32	.8352	3.2397	5/8	16.800	14.530	3/8	120.28	38.877
1/16	.8866	3.3379	11/16	17.257	14.726	1/2	122.72	39.270
3/32	.9396	3.4361	3/4	17.721	14.923	5/8	125.19	39.663
1/8	.9940	3.5343	13/16	18.190	15.119	3/4	127.68	40.055
5/32	1.0500	3.6324	7/8	18.665	15.315	7/8	130.19	40.448
3/16	1.1075	3.7306	15/16	19.147	15.512	13.	132.73	40.841
7/32	1.1666	3.8288	5.	19.635	15.708	1/8	135.30	41.233
1/4	1.2272	3.9270	1/16	20.129	15.904	1/4	137.89	41.626
9/32	1.2893	4.0251	1/8	20.629	16.101	3/8	140.50	42.019
5/16	1.3530	4.1233	3/16	21.135	16.297	1/2	143.14	42.412
11/32	1.4182	4.2215	1/4	21.648	16.493	5/8	145.80	42.804
3/8	1.4849	4.3197	5/16	22.166	16.690	3/4	148.49	43.197
13/32	1.5531	4.4178	3/8	22.691	16.886	7/8	151.20	43.590
7/16	1.6230	4.5160	7/16	23.221	17.082	14.	153.94	43.982
15/32	1.6943	4.6142	1/2	23.758	17.279	1/8	156.70	44.375
1/2	1.7671	4.7124	9/16	24.301	17.475	1/4	159.48	44.768
17/32	1.8415	4.8105	5/8	24.850	17.671	3/8	162.30	45.160
9/16	1.9175	4.9087	11/16	25.406	17.868	1/2	165.13	45.553
19/32	1.9949	5.0070	3/4	25.967	18.064	5/8	167.99	45.946
5/8	2.0739	5.1051	13/16	26.535	18.261	3/4	170.87	46.338
21/32	2.1545	5.2033	7/8	27.109	18.457	7/8	173.78	46.731
11/16	2.2365	5.3014	15/16	27.688	18.653	15.	176.71	47.124
23/32	2.3201	5.3996	6.	28.274	18.850	1/8	179.67	47.517
3/4	2.4053	5.4978	1/8	29.465	19.242	1/4	182.65	47.909
25/32	2.4919	5.5960	1/4	30.680	19.635	3/8	185.66	48.302
13/16	2.5802	5.6941	3/8	31.919	20.028	1/2	188.69	48.695
27/32	2.6700	5.7923	1/2	33.183	20.420	5/8	191.75	49.087
7/8	2.7612	5.8905	5/8	34.472	20.813	3/4	194.83	49.480
29/32	2.8540	5.9887	3/4	35.785	21.206	7/8	197.93	49.873
15/16	2.9483	6.0868	7/8	37.122	21.598	16.	201.06	50.265
31/32	3.0442	6.1850	7.	38.485	21.991	1/8	204.22	50.658
2.	3.1416	6.2832	1/8	39.871	22.384	1/4	207.39	51.051
1/16	3.3410	6.4795	1/4	41.282	22.776	3/8	210.60	51.444
1/8	3.5466	6.6759	3/8	42.718	23.169	1/2	213.82	51.836
3/16	3.7583	6.8722	1/2	44.179	23.562	5/8	217.08	52.229
1/4	3.9761	7.0686	5/8	45.664	23.955	3/4	220.35	52.622
5/16	4.2000	7.2649	3/4	47.173	24.347	7/8	223.65	53.014

AREAS AND CIRCUMFERENCES OF CIRCLES

Diam.	Area	Circum.	Diam.	Area	Circum.	Diam.	Area	Circum.
17.	226.98	53.407	26.	530.93	81.681	35.	962.11	109.956
1/8	230.33	53.800	1/8	536.05	82.074	1/8	969.00	110.348
1/4	233.71	54.192	1/4	541.19	82.467	1/4	975.91	110.741
3/8	237.10	54.585	3/8	546.35	82.860	3/8	982.84	111.134
1/2	240.53	54.978	1/2	551.55	83.252	1/2	989.80	111.527
5/8	243.98	55.371	5/8	556.76	83.645	5/8	996.78	111.919
3/4	247.45	55.763	3/4	562.00	84.038	3/4	1003.8	112.312
7/8	250.95	56.156	7/8	567.27	84.430	7/8	1010.8	112.705
18.	254.47	56.549	27.	572.56	84.823	36.	1017.9	113.097
1/8	258.02	56.941	1/8	577.87	85.216	1/8	1025.0	113.490
1/4	261.59	57.334	1/4	583.21	85.608	1/4	1032.1	113.883
3/8	265.18	57.727	3/8	588.57	86.001	3/8	1039.2	114.275
1/2	268.80	58.119	1/2	593.96	86.394	1/2	1046.3	114.668
5/8	272.45	58.512	5/8	599.37	86.786	5/8	1053.5	115.061
3/4	276.12	58.905	3/4	604.81	87.179	3/4	1060.7	115.454
7/8	279.81	59.298	7/8	610.27	87.572	7/8	1068.0	115.846
19.	283.53	59.690	28.	615.75	87.965	37.	1075.2	116.239
1/8	287.27	60.083	1/8	621.26	88.357	1/8	1082.5	116.632
1/4	291.04	60.476	1/4	626.80	88.750	1/4	1089.8	117.024
3/8	294.83	60.868	3/8	632.36	89.143	3/8	1097.1	117.417
1/2	298.65	61.261	1/2	637.94	89.535	1/2	1104.5	117.810
5/8	302.49	61.654	5/8	643.55	89.928	5/8	1111.8	118.202
3/4	306.35	62.046	3/4	649.18	90.321	3/4	1119.2	118.596
7/8	310.24	62.439	7/8	654.84	90.713	7/8	1126.7	118.988
20.	314.16	62.832	29.	660.52	91.106	38.	1134.1	119.381
1/8	318.10	63.225	1/8	666.23	91.499	1/8	1141.6	119.773
1/4	322.06	63.617	1/4	671.96	91.892	1/4	1149.1	120.166
3/8	326.05	64.010	3/8	677.71	92.284	3/8	1156.6	120.559
1/2	330.06	64.403	1/2	683.49	92.677	1/2	1164.2	120.951
5/8	334.10	64.795	5/8	689.30	93.070	5/8	1171.7	121.344
3/4	338.16	65.188	3/4	695.13	93.462	3/4	1179.3	121.737
7/8	342.25	65.581	7/8	700.98	93.855	7/8	1186.9	122.129
21.	346.36	65.973	30.	706.86	94.248	39.	1194.6	122.522
1/8	350.50	66.366	1/8	712.76	94.640	1/8	1202.3	122.915
1/4	354.66	66.759	1/4	718.69	95.033	1/4	1210.0	123.308
3/8	358.84	67.152	3/8	724.64	95.426	3/8	1217.7	123.700
1/2	363.05	67.544	1/2	730.62	95.819	1/2	1225.4	124.093
5/8	367.28	67.937	5/8	736.62	96.211	5/8	1233.2	124.486
3/4	371.54	68.330	3/4	742.64	96.604	3/4	1241.0	124.878
7/8	375.83	68.722	7/8	748.69	96.997	7/8	1248.8	125.271
22.	380.13	69.115	31.	754.77	97.389	40.	1256.6	125.664
1/8	384.46	69.508	1/8	760.87	97.782	1/8	1264.5	126.056
1/4	388.82	69.900	1/4	766.99	98.175	1/4	1272.4	126.449
3/8	393.20	70.293	3/8	773.14	98.567	3/8	1280.3	126.842
1/2	397.61	70.686	1/2	779.31	98.960	1/2	1288.2	127.235
5/8	402.04	71.079	5/8	785.51	99.353	5/8	1296.2	127.627
3/4	406.49	71.471	3/4	791.73	99.746	3/4	1304.2	128.020
7/8	410.97	71.864	7/8	797.98	100.138	7/8	1312.2	128.413
23.	415.48	72.257	32.	804.25	100.531	41.	1320.3	128.805
1/8	420.00	72.649	1/8	810.54	100.924	1/8	1328.3	129.198
1/4	424.56	73.042	1/4	816.86	101.316	1/4	1336.4	129.591
3/8	429.13	73.435	3/8	823.21	101.709	3/8	1344.5	129.983
1/2	433.74	73.827	1/2	829.58	102.102	1/2	1352.7	130.376
5/8	438.36	74.220	5/8	835.97	102.494	5/8	1360.8	130.769
3/4	443.01	74.613	3/4	842.39	102.887	3/4	1369.0	131.161
7/8	447.69	75.006	7/8	848.83	103.280	7/8	1377.2	131.554
24.	452.39	75.398	33.	855.30	103.673	42.	1385.4	131.947
1/8	457.11	75.791	1/8	861.79	104.065	1/8	1393.7	132.340
1/4	461.86	76.184	1/4	868.31	104.458	1/4	1402.0	132.732
3/8	466.64	76.576	3/8	874.85	104.851	3/8	1410.3	133.125
1/2	471.44	76.969	1/2	881.41	105.243	1/2	1418.6	133.518
5/8	476.26	77.362	5/8	888.00	105.636	5/8	1427.0	133.910
3/4	481.11	77.754	3/4	894.62	106.029	3/4	1435.4	134.303
7/8	485.98	78.147	7/8	901.26	106.421	7/8	1443.8	134.696
25.	490.87	78.540	34.	907.92	106.814	43.	1452.2	135.088
1/8	495.79	78.933	1/8	914.61	107.207	1/8	1460.7	135.481
1/4	500.74	79.325	1/4	921.32	107.600	1/4	1469.1	135.874
3/8	505.71	79.718	3/8	928.06	107.992	3/8	1477.6	136.267
1/2	510.71	80.111	1/2	934.82	108.385	1/2	1486.2	136.659
5/8	515.72	80.503	5/8	941.61	108.778	5/8	1494.7	137.052
3/4	520.77	80.896	3/4	948.42	109.170	3/4	1503.3	137.445
7/8	525.84	81.289	7/8	955.25	109.563	7/8	1511.9	137.837

AREAS AND CIRCUMFERENCES OF CIRCLES

Diam.	Area	Circum.	Diam.	Area	Circum.	Diam.	Area	Circum.
44.	1520.5	138.230	53 3/8	2237.5	167.683	62 3/4	3092.6	197.135
1/8	1529.2	138.623	1/2	2248.0	168.075	7/8	3104.9	197.528
1/4	1537.9	139.015	5/8	2258.5	168.468	63.	3117.2	197.920
3/8	1546.6	139.408	3/4	2269.1	168.861	1/8	3129.6	198.313
1/2	1555.3	139.801	7/8	2279.6	169.253	1/4	3142.0	198.706
5/8	1564.0	140.194	54.	2290.2	169.646	3/8	3154.5	199.098
3/4	1572.8	140.586	1/8	2300.8	170.039	1/2	3166.9	199.491
7/8	1581.6	140.979	1/4	2311.5	170.431	5/8	3179.4	199.884
45.	1590.4	141.372	3/8	2322.1	170.824	3/4	3191.9	200.277
1/8	1599.3	141.764	1/2	2332.8	171.217	7/8	3204.4	200.669
1/4	1608.2	142.157	5/8	2343.5	171.609	64.	3217.0	201.062
3/8	1617.0	142.550	3/4	2354.3	172.002	1/8	3229.6	201.455
1/2	1626.0	142.942	7/8	2365.0	172.395	1/4	3242.2	201.847
5/8	1634.9	143.335	55.	2375.8	172.788	3/8	3254.8	202.240
3/4	1643.9	143.728	1/8	2386.6	173.180	1/2	3267.5	202.633
7/8	1652.9	144.121	1/4	2397.5	173.573	5/8	3280.1	203.025
46.	1661.9	144.513	3/8	2408.3	173.966	3/4	3292.8	203.418
1/8	1670.9	144.906	1/2	2419.2	174.358	7/8	3305.6	203.811
1/4	1680.0	145.299	5/8	2430.1	174.751	65.	3318.3	204.204
3/8	1689.1	145.691	3/4	2441.1	175.144	1/8	3331.1	204.596
1/2	1698.2	146.084	7/8	2452.0	175.536	1/4	3343.9	204.989
5/8	1707.4	146.477	56.	2463.0	175.929	3/8	3356.7	205.382
3/4	1716.5	146.869	1/8	2474.0	176.322	1/2	3369.6	205.774
7/8	1725.7	147.262	1/4	2485.0	176.715	5/8	3382.4	206.167
47.	1734.9	147.655	3/8	2496.1	177.107	3/4	3395.3	206.560
1/8	1744.2	148.048	1/2	2507.2	177.500	7/8	3408.2	206.952
1/4	1753.5	148.440	5/8	2518.3	177.893	66.	3421.2	207.345
3/8	1762.7	148.833	3/4	2529.4	178.285	1/8	3434.2	207.738
1/2	1772.1	149.226	7/8	2540.6	178.678	1/4	3447.2	208.131
5/8	1781.4	149.618	57.	2551.8	179.071	3/8	3460.2	208.523
3/4	1790.8	150.011	1/8	2563.0	179.463	1/2	3473.2	208.916
7/8	1800.1	150.404	1/4	2574.2	179.856	5/8	3486.3	209.309
48.	1809.6	150.796	3/8	2585.4	180.249	3/4	3499.4	209.701
1/8	1819.0	151.189	1/2	2596.7	180.642	7/8	3512.5	210.094
1/4	1828.5	151.582	5/8	2608.0	181.034	67.	3525.7	210.487
3/8	1837.9	151.975	3/4	2619.4	181.427	1/8	3538.8	210.879
1/2	1847.5	152.367	7/8	2630.7	181.820	1/4	3552.0	211.272
5/8	1857.0	152.760	58.	2642.1	182.212	3/8	3565.2	211.665
3/4	1866.5	153.153	1/8	2653.5	182.605	1/2	3578.5	212.058
7/8	1876.1	153.545	1/4	2664.9	182.998	5/8	3591.7	212.450
49.	1885.7	153.938	3/8	2676.4	183.390	3/4	3605.0	212.843
1/8	1895.4	154.331	1/2	2687.8	183.783	7/8	3618.3	213.236
1/4	1905.0	154.723	5/8	2699.3	184.176	68.	3631.7	213.628
3/8	1914.7	155.116	3/4	2710.9	184.569	1/8	3645.0	214.021
1/2	1924.4	155.509	7/8	2722.4	184.961	1/4	3658.4	214.414
5/8	1934.2	155.902	59.	2734.0	185.354	3/8	3671.8	214.806
3/4	1943.9	156.294	1/8	2745.6	185.747	1/2	3685.3	215.199
7/8	1953.7	156.687	1/4	2757.2	186.139	5/8	3698.7	215.592
50.	1963.5	157.080	3/8	2768.8	186.532	3/4	3712.2	215.984
1/8	1973.3	157.472	1/2	2780.5	186.925	7/8	3725.7	216.377
1/4	1983.2	157.865	5/8	2792.2	187.317	69.	3739.3	216.770
3/8	1993.1	158.258	3/4	2803.9	187.710	1/8	3752.8	217.163
1/2	2003.0	158.650	7/8	2815.7	188.103	1/4	3766.4	217.555
5/8	2012.9	159.043	60.	2827.4	188.496	3/8	3780.0	217.948
3/4	2022.8	159.436	1/8	2839.2	188.888	1/2	3793.7	218.341
7/8	2032.8	159.829	1/4	2851.0	189.281	5/8	3807.3	218.733
51.	2042.8	160.221	3/8	2862.9	189.674	3/4	3821.0	219.126
1/8	2052.8	160.614	1/2	2874.8	190.066	7/8	3834.7	219.519
1/4	2062.9	161.007	5/8	2886.6	190.459	70.	3848.5	219.911
3/8	2073.0	161.399	3/4	2898.6	190.852	1/8	3862.2	220.304
1/2	2083.1	161.792	7/8	2910.5	191.244	1/4	3876.0	220.697
5/8	2093.2	162.185	61.	2922.5	191.637	3/8	3889.8	221.090
3/4	2103.3	162.577	1/8	2934.5	192.030	1/2	3903.6	221.482
7/8	2113.5	162.970	1/4	2946.5	192.423	5/8	3917.5	221.875
52.	2123.7	163.363	3/8	2958.5	192.815	3/4	3931.4	222.268
1/8	2133.9	163.756	1/2	2970.6	193.208	7/8	3945.3	222.660
1/4	2144.2	164.148	5/8	2982.7	193.601	71.	3959.2	223.053
3/8	2154.5	164.541	3/4	2994.8	193.993	1/8	3973.1	223.446
1/2	2164.8	164.934	7/8	3006.9	194.386	1/4	3987.1	223.838
5/8	2175.1	165.326	62.	3019.1	194.779	3/8	4001.1	224.231
3/4	2185.4	165.719	1/8	3031.3	195.171	1/2	4015.2	224.624
7/8	2195.8	166.112	1/4	3043.5	195.564	5/8	4029.2	225.017
53.	2206.2	166.504	3/8	3055.7	195.957	3/4	4043.3	225.409
1/8	2216.6	166.897	1/2	3068.0	196.350	7/8	4057.4	225.802
1/4	2227.0	167.290	5/8	3080.3	196.742	72.	4071.5	226.195

AREAS AND CIRCUMFERENCES OF CIRCLES

Diam.	Area	Circum.	Diam.	Area.	Circum.	Diam.	Area	Circum.
72	4085.7	226.587	81 1/2	5216.8	256.040	90 7/8	6486.0	285.492
1/8	4099.8	226.980	5/8	5232.8	256.433	91.	6503.9	285.885
1/4	4114.0	227.373	3/4	5248.9	256.825	1/8	6521.8	286.278
3/8	4128.2	227.765	7/8	5264.9	257.218	1/4	6539.7	286.670
1/2	4142.5	228.158	82.	5281.0	257.611	3/8	6557.6	287.063
5/8	4156.8	228.551	1/8	5297.1	258.003	1/2	6575.5	287.456
3/4	4171.1	228.944	1/4	5313.3	258.396	5/8	6593.5	287.848
7/8	4185.4	229.336	3/8	5329.4	258.789	3/4	6611.5	288.241
73.	4199.7	229.729	1/2	5345.6	259.181	7/8	6629.6	288.634
1/8	4214.1	230.122	5/8	5361.8	259.574	92.	6647.6	289.027
1/4	4228.5	230.514	3/4	5378.1	259.967	1/8	6665.7	289.419
3/8	4242.9	230.907	7/8	5394.3	260.359	1/4	6683.8	289.812
1/2	4257.4	231.300	83.	5410.6	260.752	3/8	6701.9	290.205
5/8	4271.8	231.692	1/8	5426.9	261.145	1/2	6720.1	290.597
3/4	4286.3	232.085	1/4	5443.3	261.538	5/8	6738.2	290.990
7/8	4300.8	232.478	3/8	5459.6	261.930	3/4	6756.4	291.383
74.	4315.4	232.871	1/2	5476.0	262.323	7/8	6774.7	291.775
1/8	4329.9	233.263	5/8	5492.4	262.716	93.	6792.9	292.168
1/4	4344.5	233.656	3/4	5508.8	263.108	1/8	6811.2	292.561
3/8	4359.2	234.049	7/8	5525.3	263.501	1/4	6829.5	292.954
1/2	4373.8	234.441	84.	5541.8	263.894	3/8	6847.8	293.346
5/8	4388.5	234.834	1/8	5558.3	264.286	1/2	6866.1	293.739
3/4	4403.1	235.227	1/4	5574.8	264.679	5/8	6884.5	294.132
7/8	4417.9	235.619	3/8	5591.4	265.072	3/4	6902.9	294.524
75.	4432.6	236.012	1/2	5607.9	265.465	7/8	6921.3	294.917
1/8	4447.4	236.405	5/8	5624.5	265.857	94.	6939.8	295.310
1/4	4462.2	236.798	3/4	5641.2	266.250	1/8	6958.2	295.702
3/8	4477.0	237.190	7/8	5657.8	266.643	1/4	6976.7	296.095
1/2	4491.8	237.583	85.	5674.5	267.035	3/8	6995.3	296.488
5/8	4506.7	237.976	1/8	5691.2	267.428	1/2	7013.8	296.881
3/4	4521.5	238.368	1/4	5707.9	267.821	5/8	7032.4	297.273
7/8	4536.5	238.761	3/8	5724.7	268.213	3/4	7051.0	297.666
76.	4551.4	239.154	1/2	5741.5	268.606	7/8	7069.6	298.059
1/8	4566.4	239.546	5/8	5758.3	268.999	95.	7088.2	298.451
1/4	4581.3	239.939	3/4	5775.1	269.392	1/8	7106.9	298.844
3/8	4596.3	240.332	7/8	5791.9	269.784	1/4	7125.6	299.237
1/2	4611.4	240.725	86.	5808.8	270.177	3/8	7144.3	299.629
5/8	4626.4	241.117	1/8	5825.7	270.570	1/2	7163.0	300.022
3/4	4641.5	241.510	1/4	5842.6	270.962	5/8	7181.8	300.415
7/8	4656.6	241.903	3/8	5859.6	271.355	3/4	7200.6	300.807
77.	4671.8	242.295	1/2	5876.5	271.748	7/8	7219.4	301.200
1/8	4686.9	242.688	5/8	5893.5	272.140	96.	7238.2	301.593
1/4	4702.1	243.081	3/4	5910.6	272.533	1/8	7257.1	301.986
3/8	4717.3	243.473	7/8	5927.6	272.926	1/4	7276.0	302.378
1/2	4732.5	243.866	87.	5944.7	273.319	3/8	7294.9	302.771
5/8	4747.8	244.259	1/8	5961.8	273.711	1/2	7313.8	303.164
3/4	4763.1	244.652	1/4	5978.9	274.104	5/8	7332.8	303.556
7/8	4778.4	245.044	3/8	5996.0	274.497	3/4	7351.8	303.949
78.	4793.7	245.437	1/2	6013.2	274.889	7/8	7370.8	304.342
1/8	4809.0	245.830	5/8	6030.4	275.282	97.	7389.8	304.734
1/4	4824.4	246.222	3/4	6047.6	275.675	1/8	7408.9	305.127
3/8	4839.8	246.615	7/8	6064.9	276.067	1/4	7428.0	305.520
1/2	4855.2	247.008	88.	6082.1	276.460	3/8	7447.1	305.913
5/8	4870.7	247.400	1/8	6099.4	276.853	1/2	7466.2	306.305
3/4	4886.2	247.793	1/4	6116.7	277.246	5/8	7485.3	306.698
7/8	4901.7	248.186	3/8	6134.1	277.638	3/4	7504.5	307.091
79.	4917.2	248.579	1/2	6151.4	278.031	7/8	7523.7	307.483
1/8	4932.7	248.971	5/8	6168.8	278.424	98.	7543.0	307.876
1/4	4948.3	249.364	3/4	6186.2	278.816	1/8	7562.2	308.269
3/8	4963.9	249.757	7/8	6203.7	279.209	1/4	7581.5	308.661
1/2	4979.5	250.149	89.	6221.1	279.602	3/8	7600.8	309.054
5/8	4995.2	250.542	1/8	6238.6	279.994	1/2	7620.1	309.447
3/4	5010.9	250.935	1/4	6256.1	280.387	5/8	7639.5	309.840
7/8	5026.5	251.327	3/8	6273.7	280.780	3/4	7658.9	310.232
80.	5042.3	251.720	1/2	6291.2	281.173	7/8	7678.3	310.625
1/8	5058.0	252.113	5/8	6308.8	281.565	99.	7697.7	311.018
1/4	5073.8	252.506	3/4	6326.4	281.958	1/8	7717.1	311.410
3/8	5089.6	252.898	7/8	6344.1	282.351	1/4	7736.6	311.803
1/2	5105.4	253.291	90.	6361.7	282.743	3/8	7756.1	312.196
5/8	5121.2	253.684	1/8	6379.4	283.136	1/2	7775.6	312.588
3/4	5137.1	254.076	1/4	6397.1	283.529	5/8	7795.2	312.981
7/8	5153.0	254.469	3/8	6414.9	283.921	3/4	7814.8	313.374
81.	5168.9	254.862	1/2	6432.6	284.314	7/8	7834.4	313.767
1/8	5184.9	255.254	5/8	6450.4	284.707	100.	7854.0	314.159
1/4	5200.8	255.647	3/4	6468.2	285.100			
3/8								

WEIGHT OF CIRCULAR STEEL PLATES

Dia. In.	Thickness, inches										
	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4
16	7	11	15	18	22	25	29	...	...	...	...
17	8	12	16	20	24	28	32	...	...	...	...
18	9	14	18	23	27	32	36	...	...	...	...
19	10	15	20	25	30	35	40	...	...	...	...
20	11	17	23	28	34	39	45	...	...	...	...
21	12	19	25	31	37	43	49	...	...	...	...
22	14	20	27	34	41	47	54	...	...	...	...
23	15	22	30	37	44	52	59	...	...	...	...
24	16	24	32	40	48	56	64	...	...	...	...
25	18	26	35	44	53	61	70	...	...	...	...
26	19	28	38	47	56	66	75	...	...	...	...
27	20	30	41	51	61	71	81	...	...	...	...
28	22	33	44	55	65	76	87	...	...	...	...
29	24	35	47	59	71	82	94	...	...	...	...
30	25	38	50	63	75	88	100	...	...	...	...
31	27	40	54	67	80	94	107	...	...	...	...
32	29	43	57	71	86	100	114	...	...	...	...
33	30	45	61	76	91	106	121	...	...	...	...
34	32	48	65	81	97	113	129	...	...	...	...
35	34	51	68	85	102	119	136	...	...	...	...
36	36	54	72	90	108	126	144	162	180	198	216
37	38	57	76	95	115	134	153	172	191	210	229
38	40	60	80	100	121	141	161	181	201	221	241
39	42	64	85	106	127	148	169	190	212	233	254
40	45	67	89	111	134	156	178	200	223	245	267
41	47	70	94	117	141	164	187	211	234	258	281
42	49	74	98	123	148	172	197	221	246	270	295
43	52	77	103	129	155	180	206	232	258	283	309
44	54	81	108	135	162	188	215	242	269	296	323
45	56	85	113	141	169	197	225	253	282	310	338
46	59	88	118	147	177	206	235	265	294	324	353
47	62	92	123	154	185	215	246	277	308	338	369
48	64	96	128	160	193	225	257	289	321	353	385
49	67	100	134	167	201	234	267	301	334	367	401
50	70	105	139	174	209	244	279	313	348	383	418
51	..	109	145	181	217	253	289	325	362	398	434
52	..	113	151	188	226	263	301	339	376	414	452
53	..	117	156	195	235	273	313	352	391	430	469
54	..	122	162	203	244	284	325	365	406	446	487
55	..	126	168	210	253	295	337	379	421	463	505
56	..	131	175	218	262	305	349	393	436	480	524
57	..	136	181	226	272	317	362	407	453	498	543
58	..	141	187	234	281	328	375	421	468	515	562
59	..	145	194	242	291	339	387	436	484	533	581
60	..	150	200	250	301	351	401	451	501	551	601
61	..	155	207	259	311	362	414	466	518	569	621
62	..	161	214	268	321	375	428	482	535	589	642
63	..	166	221	276	332	387	442	497	553	608	663
64	..	171	228	285	342	399	456	513	570	627	684
65	..	177	235	294	353	412	471	529	588	647	706
66	..	182	243	303	364	425	485	546	607	667	728
67	..	188	250	313	375	438	500	563	625	688	750
68	..	193	257	322	386	450	515	579	643	708	772
69	..	199	265	331	398	464	530	596	663	729	795
70	..	205	273	341	409	477	545	613	682	750	818
71	..	211	281	351	421	491	561	631	702	772	842
72	..	217	289	361	433	505	577	649	722	794	866
73	..	223	297	371	445	519	593	667	742	816	890
74	..	226	305	381	458	534	610	686	763	839	915
75	..	235	313	391	470	548	626	704	783	861	939
76	..	241	322	402	482	563	643	723	804	884	964
77	..	248	330	413	495	578	660	743	825	908	990
78	..	254	339	423	508	593	678	762	847	932	1016
79	..	260	348	434	521	608	695	782	869	956	1043
80	..	267	356	445	534	623	713	802	891	980	1069
81	..	273	365	457	548	639	731	822	913	1004	1096
82	..	280	374	468	561	655	749	842	936	1029	1123
83	..	288	384	479	575	671	767	863	959	1055	1151

WEIGHT OF CIRCULAR STEEL PLATES

Continued

Dia. In.	Thickness, inches													
	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
84	294	393	491	589	687	786	884	982	1080	1179	1277	1375	1473	1571
85	302	402	503	603	704	805	905	1006	1106	1207	1307	1408	1508	1609
86	309	412	515	618	721	824	926	1029	1132	1235	1338	1441	1544	1647
87	316	422	527	632	738	843	948	1054	1159	1265	1370	1475	1581	1686
88	323	431	539	647	755	863	970	1078	1186	1294	1402	1509	1617	1725
89	331	441	551	661	771	882	992	1102	1212	1323	1433	1543	1653	1763
90	338	451	564	677	789	902	1015	1128	1240	1353	1466	1579	1691	1804
91	345	461	576	692	807	922	1037	1153	1268	1383	1495	1614	1729	1844
92	353	471	589	707	825	943	1060	1178	1296	1414	1532	1649	1767	1885
93	362	482	602	722	843	963	1084	1204	1324	1445	1565	1686	1806	1926
94	369	492	615	738	861	984	1107	1230	1353	1476	1599	1722	1845	1968
95	377	503	628	754	879	1005	1131	1256	1382	1507	1633	1759	1884	2010
96	...	513	641	769	897	1026	1154	1282	1410	1538	1666	1795	1923	2052
97	...	524	654	785	916	1047	1178	1309	1440	1570	1701	1832	1963	2095
98	...	535	668	801	935	1069	1202	1336	1469	1603	1737	1870	2004	2139
99	...	546	682	818	954	1091	1227	1363	1500	1636	1772	1908	2045	2183
100	...	557	696	835	974	1113	1252	1391	1530	1669	1809	1948	2087	2227
101	...	568	710	852	994	1136	1278	1420	1562	1704	1846	1988	2130	2272
102	...	579	724	869	1014	1158	1303	1448	1593	1738	1882	2027	2172	2317
103	...	591	739	886	1034	1182	1329	1477	1624	1772	1919	2067	2214	2363
104	...	602	753	903	1054	1204	1355	1505	1656	1806	1957	2107	2258	2409
105	...	614	768	921	1074	1228	1381	1534	1688	1841	1994	2148	2302	2455
106	...	626	782	939	1095	1251	1408	1564	1720	1877	2033	2189	2346	2502
107	...	637	797	956	1116	1275	1434	1593	1753	1912	2071	2231	2390	2550
108	...	649	812	974	1136	1299	1461	1623	1786	1948	2110	2273	2435	2598
109	...	662	827	992	1158	1323	1488	1653	1819	1984	2149	2315	2480	2646
110	...	673	842	1010	1179	1347	1516	1684	1853	2029	2189	2358	2526	2695
111	...	686	857	1028	1200	1372	1543	1715	1886	2058	2229	2401	2572	2744
112	...	693	873	1048	1222	1397	1571	1746	1920	2095	2270	2444	2619	2793
113	...	711	889	1066	1244	1422	1599	1777	1955	2133	2310	2488	2666	2844
114	...	724	904	1085	1266	1447	1628	1809	1990	2171	2351	2532	2713	2894
115	...	736	920	1104	1288	1473	1657	1841	2025	2209	2393	2577	2761	2945
116	...	749	936	1124	1311	1498	1686	1873	2060	2247	2435	2622	2809	2997
117	...	762	953	1143	1334	1524	1715	1905	2096	2286	2477	2667	2858	3048
118	...	775	969	1163	1357	1550	1744	1938	2132	2326	2519	2713	2907	3101
119	...	788	985	1183	1380	1577	1774	1971	2168	2365	2562	2759	2956	3154
120	...	802	1002	1203	1403	1604	1804	2005	2205	2406	2606	2807	3007	3208
121	...	815	1019	1223	1426	1630	1834	2038	2242	2445	2649	2853	3057	3260
122	...	829	1036	1243	1450	1657	1864	2072	2279	2486	2693	2900	3107	3314
123	...	842	1053	1263	1474	1685	1895	2106	2316	2527	2737	2948	3159	3369
124	...	856	1070	1284	1498	1712	1926	2140	2354	2568	2782	2996	3210	3424
125	...	870	1087	1305	1522	1740	1957	2175	2392	2610	2827	3045	3262	3480
126	...	884	1105	1326	1547	1768	1989	2210	2431	2652	2872	3093	3315	3535
127	...	898	1122	1347	1571	1796	2020	2245	2469	2694	2918	3143	3367	3592
128	...	912	1140	1368	1596	1824	2052	2280	2508	2736	2964	3192	3420	3649
129	...	926	1158	1390	1621	1853	2085	2316	2548	2779	3011	3242	3474	3706
130	...	941	1176	1411	1646	1882	2117	2352	2587	2822	3058	3293	3528	3764
131	...	955	1194	1433	1672	1911	2150	2389	2627	2866	3105	3344	3583	3822
132	...	970	1213	1455	1698	1940	2183	2425	2668	2910	3153	3395	3638	3880
133	...	985	1231	1477	1723	1970	2216	2462	2708	2954	3200	3446	3693	3939
134	...	1000	1250	1500	1750	1999	2249	2499	2749	2999	3249	3499	3749	3999
135	...	1015	1268	1522	1775	2030	2284	2537	2790	3044	3298	3551	3805	4059
136	...	1029	1286	1543	1800	2057	2315	2572	2829	3086	3344	3601	3858	4115
137	...	1044	1300	1560	1820	2088	2340	2600	2860	3132	3380	3640	3900	4176
138	...	1059	1321	1585	1849	2118	2378	2642	2906	3177	3435	3699	3963	4237
139	...	1075	1344	1613	1882	2150	2419	2688	2957	3225	3494	3763	4032	4300
140	...	1090	1363	1635	1908	2180	2453	2725	2998	3270	3543	3815	4088	4361
141	...	1106	1383	1659	1936	2212	2489	2765	3042	3318	3595	3871	4148	4424
142	...	1122	1402	1682	1963	2243	2524	2804	3084	3365	3645	3926	4206	4487
143	...	1137	1422	1706	1991	2275	2560	2844	3128	3412	3697	3982	4266	4550
144	...	1153	1442	1730	2019	2307	2596	2884	3172	3460	3749	4038	4326	4614
145	...	1169	1462	1754	2047	2339	2632	2924	3216	3508	3801	4094	4386	4678
146	...	1186	1482	1778	2075	2371	2668	2964	3260	3557	3853	4150	4446	4743
147	...	1202	1503	1803	2104	2404	2705	3005	3306	3606	3907	4207	4508	4808
148	...	1218	1523	1828	2132	2437	2741	3046	3351	3655	3960	4264	4569	4874
149	...	1235	1544	1852	2161	2470	2778	3087	3396	3705	4013	4322	4631	4940
150	...	1251	1565	1877	2190	2503	2816	3129	3442	3754	4068	4381	4694	5006

TABLE OF CAPACITIES OF CYLINDERS AND SPHERES

Diam. in Feet	Cu. Ft. per Foot of Cylinder	Gallons per Foot of Cylinder	42 Gallon Barrels per Foot of Cylinder	Sphere Surface in Sq. Ft.	Sphere Volume in Cu. Ft.	Diam. in Feet	Cu. Ft. per Foot of Cylinder	Gallons per Foot of Cylinder	42 Gallon Barrels per Foot of Cylinder	Sphere Surface in Sq. Ft.	Sphere Volume in Cu. Ft.
30	706.86	5287.7	125.90	2827.4	14137	42	1385.4	10364	246.76	5541.8	38792
30 1/4	718.69	5376.2	128.00	2874.8	14494	42 1/4	1402.0	10488	249.70	5607.9	39489
30 1/2	730.62	5465.4	130.13	2922.5	14856	42 1/2	1418.6	10612	252.67	5674.5	40194
30 3/4	742.64	5555.4	132.27	2970.6	15224	42 3/4	1435.4	10737	255.65	5714.5	40908
31	754.77	5646.1	134.43	3019.1	15599	43.	1452.2	10863	258.65	5808.8	41630
31 1/4	766.99	5737.5	136.61	3068.0	15979	43 1/4	1469.1	10990	261.66	5876.5	42360
31 1/2	779.31	5829.7	138.80	3117.2	16366	43 1/2	1486.2	11117	264.70	5944.7	43099
31 3/4	791.73	5922.6	141.01	3166.9	16758	43 3/4	1503.3	11245	267.75	6013.2	43846
32	804.25	6016.2	143.24	3217.0	17157	44	1520.5	11374	270.82	6082.1	44602
32 1/4	816.86	6110.6	145.49	3267.5	17563	44 1/4	1537.9	11504	273.90	6151.4	45367
32 1/2	829.58	6205.7	147.75	3318.3	17974	44 1/2	1555.3	11634	277.01	6221.1	46140
32 3/4	842.39	6301.5	150.04	3369.6	18392	44 3/4	1572.8	11765	280.13	6291.2	46922
33	855.30	6398.1	152.34	3421.2	18817	45	1590.4	11897	283.27	6361.7	47713
33 1/4	868.31	6495.4	154.65	3473.2	19247	45 1/4	1608.2	12030	286.42	6432.6	48513
33 1/2	881.41	6593.4	156.99	3525.7	19685	45 1/2	1626.0	12163	289.60	6503.9	49321
33 3/4	894.62	6692.2	159.34	3578.5	20129	45 3/4	1643.9	12297	292.79	6575.5	50139
34	907.92	6791.7	161.71	3631.7	20580	46	1661.9	12432	296.00	6647.6	50965
34 1/4	921.32	6892.0	164.09	3685.3	21037	46 1/4	1680.0	12567	299.22	6720.1	51800
34 1/2	934.82	6992.9	166.50	3739.3	21501	46 1/2	1698.2	12704	302.47	6792.9	52645
34 3/4	948.42	7094.7	168.92	3793.7	21972	46 3/4	1716.5	12841	305.73	6866.1	53499
35	962.11	7197.1	171.36	3848.5	22449	47	1734.9	12978	309.01	6939.8	54362
35 1/4	975.91	7300.3	173.82	3903.6	22934	47 1/4	1753.5	13117	312.30	7013.8	55234
35 1/2	989.80	7404.2	176.29	3959.2	23425	47 1/2	1772.1	13256	315.62	7088.2	56115
35 3/4	1003.8	7508.9	178.78	4015.2	23924	47 3/4	1790.8	13396	318.95	7163.0	57006
36	1017.9	7614.2	181.29	4071.5	24429	48	1809.6	13536	322.30	7238.2	57906
36 1/4	1032.1	7720.4	183.82	4128.2	24942	48 1/4	1828.5	13678	325.66	7313.8	58815
36 1/2	1046.3	7827.2	186.36	4185.4	25461	48 1/2	1847.5	13820	329.05	7389.8	59734
36 3/4	1060.7	7934.8	188.92	4242.9	25988	48 3/4	1866.5	13963	332.45	7466.2	60663
37	1075.2	8043.1	191.50	4300.8	26522	49	1885.7	14106	335.86	7543.0	61601
37 1/4	1089.8	8152.2	194.10	4359.2	27063	49 1/4	1905.0	14251	339.30	7620.1	62549
37 1/2	1104.5	8262.0	196.71	4417.9	27612	49 1/2	1924.4	14396	342.75	7697.7	63506
37 3/4	1119.2	8372.5	199.35	4477.0	28168	49 3/4	1943.9	14541	346.23	7775.6	64473
38	1134.1	8483.8	201.99	4536.5	28731	50	1963.5	14688	349.71	7854.0	65450
38 1/4	1149.1	8595.8	204.66	4596.3	29302	50 1/4	1983.2	14835	353.22	7932.7	66437
38 1/2	1164.2	8708.5	207.35	4656.6	29880	50 1/2	2003.0	14983	356.74	8011.8	67433
38 3/4	1179.3	8822.0	210.05	4717.3	30466	50 3/4	2022.8	15132	360.28	8091.4	68439
39	1194.6	8936.2	212.77	4778.4	31059	51	2042.8	15281	363.84	8171.3	69456
39 1/4	1210.0	9051.1	215.50	4839.8	31660	51 1/4	2062.9	15432	367.42	8251.6	70482
39 1/2	1225.4	9166.8	218.26	4901.7	32269	51 1/2	2083.1	15582	371.01	8332.3	71519
39 3/4	1241.0	9283.2	221.03	4963.9	32886	51 3/4	2103.3	15734	374.62	8413.4	72565
40	1256.6	9400.3	223.82	5026.5	33510	52	2123.7	15887	378.25	8494.9	73622
40 1/4	1272.4	9518.2	226.62	5089.6	34143	52 1/4	2144.2	16040	381.90	8576.7	74689
40 1/2	1288.2	9636.8	229.45	5153.0	34783	52 1/2	2164.8	16193	385.56	8659.0	75766
40 3/4	1304.2	9756.1	232.29	5216.8	35431	52 3/4	2185.4	16348	389.24	8741.7	76854
41	1320.3	9876.2	235.15	5281.0	36087	53	2206.2	16503	392.94	8824.7	77952
41 1/4	1336.4	9997.0	238.02	5345.6	36751	53 1/4	2227.0	16659	396.65	8908.2	79060
41 1/2	1352.7	10119.	240.92	5410.6	37423	53 1/2	2248.0	16816	400.39	8992.0	80179
41 3/4	1369.0	10241.	243.83	5476.0	38104	53 3/4	2269.1	16974	404.14	9076.3	81308

TABLE OF CAPACITIES OF CYLINDERS AND SPHERES

Diam. in Feet	Cu. Ft. per Foot of Cylinder	Gallons per Foot of Cylinder	42 Gallon Barrels per Foot of Cylinder	Sphere Surface in Sq. Ft.	Sphere Volume in Cu. Ft.	Diam. in Feet	Cu. Ft. per Foot of Cylinder	Gallons per Foot of Cylinder	42 Gallon Barrels per Foot of Cylinder	Sphere Surface in Sq. Ft.	Sphere Volume in Cu. Ft.
54	2290.2	17132	407.91	9160.9	82448	66	3421.2	25592	609.34	13685	150533
54¼	2311.5	17291	411.69	9245.9	83598	66¼	3447.2	25787	613.97	13789	152250
54½	2332.8	17451	415.49	9331.3	84759	66½	3473.2	25982	618.61	13893	153980
54¾	2354.3	17611	419.32	9417.1	85931	66¾	3499.4	26177	623.27	13998	155723
55	2375.8	17772	423.15	9503.3	87114	67	3525.7	26374	627.95	14103	157479
55¼	2397.5	17934	427.01	9589.9	88307	67¼	3552.0	26571	632.64	14208	159249
55½	2419.2	18097	430.88	9676.9	89511	67½	3578.5	26769	637.35	14314	161031
55¾	2441.1	18260	434.77	9764.3	90726	67¾	3605.0	26967	642.08	14420	162827
56	2463.0	18245	438.68	9852.0	91952	68	3631.7	27167	646.83	14527	164636
56¼	2485.0	18589	442.61	9940.2	93189	68¼	3658.4	27367	651.59	14634	166459
56½	2507.2	18755	446.55	10029	94437	68½	3685.3	27568	656.38	14741	168295
56¾	2529.4	18921	450.51	10118	95697	68¾	3712.2	27769	661.18	14849	170144
57	2551.8	19088	454.49	10207	96967	69	3739.3	27972	665.99	14957	172007
57¼	2574.2	19256	458.48	10297	98248	69¼	3766.4	28175	670.83	15066	173883
57½	2596.7	19425	462.50	10387	99541	69½	3793.7	28379	675.68	15175	175773
57¾	2619.4	19594	466.53	10477	100845	69¾	3821.0	28583	680.55	15284	177677
58	2642.1	19764	470.57	10568	102160	70	3848.5	28788	685.44	15394	179594
58¼	2664.9	19935	474.64	10660	103487	70¼	3876.0	28994	690.34	15504	181525
58½	2687.8	20106	478.72	10751	104825	70½	3903.6	29201	695.27	15615	183470
58¾	2710.9	20279	482.82	10843	106175	70¾	3931.4	29409	700.21	15725	185429
59	2734.0	20452	486.94	10936	107536	71	3959.2	29617	705.16	15837	187402
59¼	2757.2	20625	491.08	11029	108909	71¼	3987.1	29826	710.14	15948	189388
59½	2780.5	20800	495.23	11122	110293	71½	4015.2	30035	715.13	16061	191389
59¾	2803.9	20975	499.40	11216	111690	71¾	4043.3	30246	720.14	16173	193404
60	2827.4	21151	503.59	11310	113097	72	4071.5	30457	725.17	16286	195432
60¼	2851.0	21327	507.79	11404	114517	72¼	4099.8	30669	730.21	16399	197475
60½	2874.8	21505	512.02	11499	115948	72½	4128.2	30881	735.27	16513	199532
60¾	2898.6	21683	516.26	11594	117392	72¾	4156.8	31095	740.35	16627	201603
61	2922.5	21862	520.51	11690	118847	73	4185.4	31309	745.45	16742	203689
61¼	2946.5	22041	524.79	11786	120314	73¼	4214.1	31524	750.56	16856	205789
61½	2970.6	22221	529.08	11882	121793	73½	4242.9	31739	755.70	16972	207903
61¾	2994.8	22402	533.39	11979	123285	73¾	4271.8	31956	760.85	17087	210032
62	3019.1	22584	537.72	12076	124788	74	4300.8	32173	766.01	17203	212175
62¼	3043.5	22767	542.06	12174	126304	74¼	4329.9	32390	771.20	17320	214332
62½	3068.0	22950	546.43	12272	127832	74½	4359.2	32609	776.40	17437	216505
62¾	3092.6	23134	550.81	12370	129372	74¾	4388.5	32828	781.62	17554	218692
63	3117.2	23319	555.21	12469	130924	75	4417.9	33048	786.86	17671	220893
63¼	3142.0	23504	559.62	12568	132489	75¼	4447.4	33269	792.11	17789	223110
63½	3166.9	23690	564.05	12668	134066	75½	4477.0	33490	797.38	17908	225341
63¾	3191.9	23877	568.50	12768	135656	75¾	4506 7	33712	802.67	18027	227587
64	3217.0	24065	572.97	12868	137258	76	4536.5	33935	807.98	18146	229847
64¼	3242.2	24253	577.46	12969	138873	76¼	4566.4	34159	813.30	18265	232123
64½	3267.5	24442	581.96	13070	140500	76½	4596.3	34383	818.64	18385	234414
64¾	3292.8	24632	586.48	13171	142141	76¾	4626.4	34608	824.00	18506	236719
65	3318.3	24823	591.02	13273	143793	77	4656.6	34834	829.38	18627	239040
65¼	3343.9	25014	595.57	13376	145459	77¼	4686.9	35061	834.77	18748	241376
65½	3369.6	25206	600.14	13478	147137	77½	4717.3	35288	840.19	18869	243727
65¾	3395.3	25399	604.73	13581	148828	77¾	4747.8	35516	845.62	18991	246093

TABLE OF CAPACITIES OF CYLINDERS AND SPHERES

Diam. in Feet	Cu. Ft. per Foot of Cylinder	Gallons per Foot of Cylinder	42 Gallon Barrels per Foot of Cylinder	Sphere Surface in Sq. Ft.	Sphere Volume in Cu. Ft.	Diam. in Feet	Cu. Ft. per Foot of Cylinder	Gallons per Foot of Cylinder	42 Gallon Barrels per Foot of Cylinder	Sphere Surface in Sq. Ft.	Sphere Volume in Cu. Ft.
78	4778.4	35745	851.06	19113	248475	90	6361.7	47589	1133.1	25447	381704
78¼	4809.0	35974	856.53	19236	250872	90¼	6397.1	47854	1139.4	25588	384893
78½	4839.8	36204	862.01	19359	253284	90½	6432.6	48119	1145.7	25730	388101
78¾	4870.7	36435	867.51	19483	255712	90¾	6468.2	48385	1152.0	25873	391326
79	4901.7	36667	873.02	19607	258155	91	6503.9	48652	1158.4	26016	394569
79¼	4932.7	36899	878.56	19731	260613	91¼	6539.7	48920	1164.8	26159	397830
79½	4963.9	37133	884.11	19856	263087	91½	6575.5	49189	1171.2	26302	401109
79¾	4995.2	37367	889.68	19981	265577	91¾	6611.5	49458	1177.6	26446	404405
80	5026.5	37601	895.27	20106	268083	92	6647.6	49728	1184.0	26590	407720
80¼	5058.0	37837	900.87	20232	270604	92¼	6683.8	49998	1190.4	26735	411053
80½	5089.6	38073	906.49	20358	273141	92½	6720.1	50270	1196.9	26880	414404
80¾	5121.2	38310	912.13	20485	275693	92¾	6756.4	50542	1203.4	27026	417773
81	5153.0	38547	917.79	20612	278262	93	6792.9	50814	1209.9	27172	421160
81¼	5184.9	38785	923.46	20739	280846	93¼	6829.5	51088	1216.4	27318	424566
81½	5216.8	39024	929.15	20867	283447	93½	6866.1	51362	1222.9	27465	427990
81¾	5248.9	39264	934.86	20995	286063	93¾	6902.9	51637	1229.5	27612	431432
82	5281.0	39505	940.59	21124	288696	94	6939.8	51913	1236.0	27759	434893
82¼	5313.3	39746	946.33	21253	291344	94¼	6976.7	52190	1242.6	27907	438372
82½	5345.6	39988	952.09	21382	294009	94½	7013.8	52467	1249.2	28055	441870
82¾	5378.1	40231	957.87	21512	296690	94¾	7051.0	52745	1255.8	28204	445386
83	5410.6	40474	963.67	21642	299387	95	7088.2	53024	1262.5	28353	448920
83¼	5443.3	40718	969.48	21773	302100	95¼	7125.6	53303	1269.1	28502	452474
83½	5476.0	40963	975.32	21904	304830	95½	7163.0	53583	1275.8	28652	456046
83¾	5508.8	41209	981.16	22035	307576	95¾	7200.6	53864	1282.5	28802	459637
84	5541.8	41455	987.03	22167	310339	96	7238.2	54146	1289.2	28953	463247
84¼	5574.8	41702	992.92	22299	313118	96¼	7276.0	54428	1295.9	29104	466875
84½	5607.9	41950	998.82	22432	315914	96½	7313.8	54711	1302.6	29255	470523
84¾	5641.2	42199	1004.7	22565	318726	96¾	7351.8	54995	1309.4	29407	474189
85	5674.5	42448	1010.7	22698	321555	97	7389.8	55280	1316.2	29559	477874
85¼	5707.9	42698	1016.6	22832	324401	97¼	7428.0	55565	1323.0	29712	481579
85½	5741.5	42949	1022.6	22966	327263	97½	7466.2	55851	1329.8	29865	485302
85¾	5775.1	43201	1028.6	23100	330142	97¾	7504.5	56138	1336.6	30018	489045
86	5808.8	43453	1034.6	23235	333038	98	7543.0	56425	1343.5	30172	492807
86¼	5842.6	43706	1040.6	23371	335951	98¼	7581.5	56714	1350.3	30326	496588
86½	5876.5	43960	1046.7	23506	338881	98½	7620.1	57003	1357.2	30481	500388
86¾	5910.6	44214	1052.7	23642	341828	98¾	7658.9	57292	1364.1	30635	504208
87	5944.7	44469	1058.8	23779	344791	99	7697.7	57583	1371.0	30791	508047
87¼	5978.9	44725	1064.9	23916	347772	99¼	7736.6	57874	1377.9	30946	511906
87½	6013.2	44982	1071.0	24053	350770	99½	7775.6	58166	1384.9	31103	515784
87¾	6047.6	45239	1077.1	24190	353785	99¾	7814.8	58458	1391.9	31259	519682
88	6082.1	45497	1083.3	24328	356818	100	7854.0	58752	1398.9	31416	523599
88¼	6116.7	45756	1089.4	24467	359868	100¼	7893.3	59046	1405.9	31573	527536
88½	6151.4	46016	1095.6	24606	362935	100½	7932.7	59341	1412.9	31731	531492
88¾	6186.2	46276	1101.8	24745	366019	100¾	7972.2	59636	1419.9	31889	535468
89	6221.1	46537	1108.0	24885	369121	101	8011.8	59933	1427.0	32047	539464
89¼	6256.1	46799	1114.3	25025	372240	101¼	8051.6	60230	1434.0	32206	543480
89½	6291.2	47062	1120.5	25165	375377	101½	8091.4	60528	1441.1	32365	547516
89¾	6326.4	47325	1126.8	25306	378531	101¾	8131.3	60826	1448.2	32525	551572

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102	8171.3	61125	1455.4	32685	555647	114	10207	76354	1818.0	40828	775735
102¼	8211.4	61425	1462.5	32846	559743	114¼	10252	76689	1825.9	41007	780849
102½	8251.6	61726	1469.7	33006	563859	114½	10297	77025	1833.9	41187	785986
102¾	8291.9	62028	1476.8	33168	567994	114¾	10342	77362	1841.9	41367	791146
103	8332.3	62330	1484.0	33329	572151	115	10387	77699	1850.0	41548	796328
103¼	8372.8	62633	1491.3	33491	576327	115¼	10432	78038	1858.0	41728	801533
103½	8413.4	62936	1498.5	33654	580523	115½	10477	78376	1866.1	41910	806760
103¾	8454.1	63241	1505.7	33816	584740	115¾	10523	78716	1874.2	42091	812010
104	8494.9	63546	1513.0	33979	588977	116	10568	79057	1882.3	42273	817283
104¼	8535.8	63852	1520.3	34143	593235	116¼	10614	79398	1890.4	42456	822579
104½	8576.7	64159	1527.6	34307	597513	116½	10660	79739	1898.6	42638	827897
104¾	8617.8	64466	1534.9	34471	601812	116¾	10705	80082	1906.7	42822	833238
105	8659.0	64774	1542.2	34636	606131	117	10751	80425	1914.9	43005	838603
105¼	8700.3	65083	1549.6	34801	610471	117¼	10797	80769	1923.1	43189	843990
105½	8741.7	65392	1557.0	34967	614831	117½	10843	81114	1931.3	43374	849400
105¾	8783.2	65703	1564.3	35133	619213	117¾	10890	81460	1939.5	43558	854833
106	8824.7	66014	1571.8	35299	623615	118	10936	81806	1947.8	43744	860290
106¼	8866 4	66325	1579.2	35466	628037	118¼	10982	82153	1956.0	43929	865769
106½	8908.2	66638	1586.6	35633	632481	118½	11029	82501	1964.3	44115	871272
106¾	8950.1	66951	1594.1	35800	636945	118¾	11075	82849	1972.6	44301	876798
107	8992.0	67265	1601.5	35968	641431	119	11122	83199	1980.9	44488	882347
107¼	9034.1	67580	1609.0	36136	645938	119¼	11169	83548	1989.2	44675	887920
107½	9076.3	67895	1616.6	36305	650465	119½	11216	83899	1997.6	44863	893516
107¾	9118.5	68211	1624.1	36474	655014	119¾	11263	84251	2006.0	45051	899136
108	9160.9	68528	1631.6	36644	659584	120	11310	84603	2014.3	45239	904779
108¼	9203.3	68846	1639.2	36813	664175	120¼	11357	84956	2022.8	45428	910445
108½	9245.9	69164	1646.8	36984	668787	120½	11404	85309	2031.2	45617	916136
108¾	9288.6	69483	1654.4	37154	673421	120¾	11452	85664	2039.6	45806	921850
109	9331.3	69803	1662.0	37325	678076	121	11499	86019	2048.1	45996	927587
109¼	9374.2	70124	1669.6	37497	682752	121¼	11547	86374	2056.5	46186	933349
109½	9417.1	70445	1677.3	37668	687450	121½	11594	86731	2065.0	46377	939134
109¾	9460.2	70767	1684.9	37841	692169	121¾	11642	87088	2073.5	46568	944943
110	9503.3	71090	1692.6	38013	696910	122	11690	87446	2082.1	46759	950776
110¼	9546.6	71413	1700.3	38186	701672	122¼	11738	87805	2090.6	46951	956633
110½	9589.9	71737	1708.0	38360	706457	122½	11786	88165	2099.2	47144	962514
110¾	9633.4	72062	1715.8	38533	711262	122¾	11834	88525	2107.7	47336	968419
111	9676.9	72388	1723.5	38708	716090	123	11882	88886	2116.3	47529	974348
111¼	9720.5	72715	1731.3	38882	720939	123¼	11931	89247	2124.9	47723	980301
111½	9764.3	73042	1739.1	39057	725810	123½	11979	89610	2133.6	47916	986278
111¾	9808.1	73370	1746.9	39232	730704	123¾	12028	89973	2142.2	48111	992280
112	9852.0	73698	1754.7	39408	735619	124	12076	90337	2150.9	48305	998306
112¼	9896.1	74028	1762.6	39584	740556	124¼	12125	90701	2159.6	48500	1004356
112½	9940.2	74358	1770.4	39761	745515	124½	12174	91067	2168.3	48695	1010431
112¾	9984.4	74689	1778.3	39938	750496	124¾	12223	91433	2177.0	48891	1016530
113	10029	75020	1786.2	40115	755499	125	12272	91800	2185.7	49087	1022654
113¼	10073	75353	1794.1	40293	760525	125¼	12321	92167	2194.5	49284	1028802
113½	10118	75686	1802.0	40471	765572	125½	12370	92536	2203.2	49481	1034975
113¾	10162	76019	1810.0	40649	770642	125¾	12420	92905	2212.0	49678	1041172

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126	12469	93274	2220.8	49876	1047394	138	14957	111887	2664.0	59828	1376055
126¼	12519	93645	2229.6	50074	1053641	138¼	15011	112293	2673.6	60045	1383547
126½	12568	94016	2238.5	50273	1059913	138½	15066	112699	2683.3	60263	1391067
126¾	12618	94388	2247.3	50471	1066209	138¾	15120	113107	2693.0	60481	1398613
127	12668	94761	2256.2	50671	1072531	139	15175	113514	2702.7	60699	1406187
127¼	12718	95134	2265.1	50870	1078877	139¼	15229	113923	2712.5	60917	1413788
127½	12768	95508	2274.0	51071	1085248	139½	15284	114333	2722.2	61136	1421416
127¾	12818	95883	2282.9	51271	1091645	139¾	15339	114743	2732.0	61356	1429072
128	12868	96259	2291.9	51472	1098066	140	15394	115154	2741.8	61575	1436755
128¼	12918	96635	2300.8	51673	1104513	140¼	15449	115565	2751.6	61795	1444466
128½	12969	97013	2309.8	51875	1110985	140½	15504	115978	2761.4	62016	1452204
128¾	13019	97390	2318.8	52077	1117481	140¾	15559	116391	2771.2	62237	1459970
129	13070	97769	2327.8	52279	1124004	141	15615	116805	2781.1	62458	1467763
129¼	13121	98148	2336.9	52482	1130551	141¼	15670	117219	2790.9	62680	1475584
129½	13171	98528	2345.9	52685	1137124	141½	15725	117634	2800.8	62902	1483433
129¾	13222	98909	2355.0	52889	1143723	141¾	15781	118050	2810.7	63124	1491310
130	13273	99291	2364.1	53093	1150347	142	15837	118467	2820.6	63347	1499214
130¼	13324	99673	2373.2	53297	1156996	142¼	15893	118885	2830.6	63570	1507146
130½	13376	100056	2382.3	53502	1163671	142½	15948	119303	2840.5	63794	1515107
130¾	13427	100440	2391.4	53707	1170371	142¾	16005	119722	2850.5	64018	1523095
131	13478	100824	2400.6	53913	1177098	143	16061	120142	2860.5	64242	1531111
131¼	13530	101209	2409.7	54119	1183850	143¼	16117	120562	2870.5	64467	1539156
131½	13581	101595	2418.9	54325	1190627	143½	16173	120983	2880.6	64692	1547228
131¾	13633	101982	2428.1	54532	1197431	143¾	16230	121405	2890.6	64918	1555329
132	13685	102369	2437.4	54739	1204260	144	16286	121828	2900.7	65144	1563458
132¼	13737	102757	2446.6	54947	1211116	144¼	16343	122251	2910.7	65370	1571615
132½	13789	103146	2455.9	55155	1217997	144½	16399	122675	2920.8	65597	1579800
132¾	13841	103536	2465.1	55363	1224904	144¾	16456	123100	2931.0	65824	1588014
133	13893	103926	2474.4	55572	1231838	145	16513	123526	2941.1	66052	1596256
133¼	13945	104317	2483.7	55781	1238797	145¼	16570	123952	2951.2	66280	1604527
133½	13998	104709	2493.1	55990	1245783	145½	16627	124379	2961.4	66508	1612826
133¾	14050	105102	2502.4	56200	1252795	145¾	16684	124807	2971.6	66737	1621154
134	14103	105495	2511.8	56410	1259833	146	16742	125235	2981.8	66966	1629511
134¼	14155	105889	2521.2	56621	1266898	146¼	16799	125665	2992.0	67196	1637896
134½	14208	106284	2530.6	56832	1273988	146½	16856	126095	3002.3	67426	1646310
134¾	14261	106679	2540.0	57044	1281106	146¾	16914	126525	3012.5	67656	1654752
135	14314	107075	2549.4	57256	1288249	147	16972	126957	3022.8	67887	1663224
135¼	14367	107472	2558.9	57468	1295420	147¼	17029	127389	3033.1	68118	1671724
135½	14420	107870	2568.3	57680	1302616	147½	17087	127822	3043.4	68349	1680253
135¾	14473	108268	2577.8	57893	1309840	147¾	17145	128256	3053.7	68581	1688811
136	14527	108667	2587.3	58107	1317090	148	17203	128690	3064.0	68813	1697398
136¼	14580	109067	2596.8	58321	1324366	148¼	17262	129125	3074.4	69046	1706015
136½	14634	109468	2606.4	58535	1331670	148½	17320	129561	3084.8	69279	1714660
136¾	14687	109869	2615.9	58750	1339000	148¾	17378	129998	3095.2	69513	1723334
137	14741	110271	2625.5	58965	1346357	149	17437	130435	3105.6	69746	1732038
137¼	14795	110674	2635.1	59180	1353741	149¼	17495	130873	3116.0	69981	1740771
137½	14849	111078	2644.7	59396	1361152	149½	17554	131312	3126.5	70215	1749533
137¾	14903	111482	2654.3	59612	1368590	149¾	17613	131751	3136.9	70450	1758325
						150	17671	132192	3147.4	70686	1767146

BIRMINGHAM WIRE GAGE (B. W. G.)

ALSO KNOWN AS STUBS IRON WIRE GAGE

EQUIVALENTS IN INCHES AND MILLIMETERS

CORRESPONDING WEIGHTS OF FLAT ROLLED STEEL

UNCOATED MATERIAL

Gage Number	THICKNESS							Millimeters	APPROXIMATE WEIGHT		Gage Number
	Inch Decimals	Inch Fractions							Pounds per Square Foot	Kilograms per Square Meter	
		32	64	128	256	512	1024				
00,000	.500	16						12.70	20.40	99.60	00,000
0,000	.454		29					11.53	18.52	90.42	0,000
000	.425		27					10.80	17.34	84.66	000
00	.380			49				9.652	15.50	75.70	00
0	.340	11						8.636	13.87	67.73	0
1	.300		19					7.620	12.24	59.76	1
2	.284	9						7.214	11.59	56.57	2
3	.259			33				6.579	10.57	51.59	3
4	.238		15					6.045	9,710	47.41	4
5	.220	7						5.588	8.976	43.82	5
6	.203		13					5.156	8.282	40.44	6
7	.180			23				4.572	7.344	35.86	7
8	.165			21				4.191	6.732	32.87	8
9	.148			19				3.759	6.038	29.48	9
10	.134			17				3.404	5.467	26.69	10
11	.120			15				3.048	4.896	23.90	11
12	.109		7					2.769	4.447	21.71	12
13	.095	3						2.413	3.876	18.92	13
14	.083				21			2.108	3.386	16.53	14
15	.072					37		1.829	2.938	14.34	15
16	.065					33		1.651	2.652	12.95	16
17	.058				15			1.473	2.366	11.55	17
18	.049					25		1.245	1.999	9.761	18
19	.042				11			1.067	1.714	8.366	19
20	035				9			.889	1.428	6.972	20
21	.032	1						.813	1.306	6.374	21
22	.028				7			.711	1.142	5.578	22
23	.025					13		.635	1.020	4.980	23
24	.022					11		.559	0.898	4.382	24
25	.020				5			.508	0.816	3.984	25
26	.018					9		.457	0.734	3.586	26
27	.016		1					.406	0.653	3.187	27
28	.014					7		.356	0.571	2.789	28
29	.013						13	.330	0.530	2.590	29
30	.012				3			.305	0.490	2.390	30
31	.010					5		.254	0.408	1.992	31
32	.009						9	.229	0.367	1.793	32
33	.008			1				.203	0.326	1.594	33
34	.007						7	.178	0.286	1.394	34
35	.005						5	.127	0.204	0.996	35
36	.004				1			.102	0.163	0.797	36
		32	64	128	256	512	1024				

B.W.G. is commonly used for strips, bands, hoops, wire and plates.
Weights are based on 489.6 pounds per cubic foot.
This gage should not be confused with New Birmingham Standard Sheet & Hoop Gage (B. G.)

GALLONS CAPACITY OF RECTANGULAR TANKS

Width of Tank	Length of Tank																				
	ft. 2	ft. in. 2 6	ft. 3	ft. in. 3 6	ft. 4	ft. in. 4 6	ft. 5	ft. in. 5 6	ft. 6	ft. in. 6 6	ft. 7	ft. in. 7 6	ft 8	ft. in. 8 6	ft. 9	ft in. 9 6	ft. 10	ft in. 10 6	ft. 11	ft. in. 11 6	ft. 12
2 ft.	29.92	37.40	44.88	52.36	59.84	67.32	74.81	82.29	89.77	97.25	104.73	112.21	119.69	127.17	134.65	142.13	149.61	157.09	164 57	172.05	179.53
2 6 in.	.....	46.75	56.10	65.45	74.80	84.16	93.51	102.86	112.21	121.56	130.91	140.26	149.61	158.96	168.31	177.66	187.01	196.36	205.71	215.06	224.41
3	.....	.....	67.32	78.54	89.77	100.99	112.21	123.43	134.65	145.87	157.09	168.31	179.53	190.75	202.97	213.19	224.41	235.63	246.86	258.07	269 30
3 6 in.	.....	.....	.....	91.64	104.73	117.82	130.91	144.00	157.09	170.18	183.27	196.36	209.45	222.54	235.63	248.73	261.82	274.90	288.00	301.09	314.18
4	.....	.....	.....	.....	119.69	134.65	149.61	164.57	179.53	194.49	209.45	224.41	239.37	254.34	269.30	284.26	299.22	314.18	329.14	344.10	359.06
4 6 in.	.....	.....	.....	.....	.....	151.48	168.31	185.14	201.97	218.80	235.63	252.47	269.30	286.13	302.96	319.79	336.62	353.45	370.28	387.11	403.94
5	.....	.....	.....	.....	.....	.....	187.01	205 71	224 41	243.11	261.82	280.52	299.22	317.92	336 62	355.32	374.03	392.72	411.43	430.13	448.83
5 6 in.	.....	.....	.....	.....	.....	.....	.....	226.28	246.86	267.43	288.00	308.57	329.14	349.71	370.28	390.85	411.43	432.00	452.57	473.14	493.71
6	.....	.....	.....	.....	.....	.....	.....	.....	269.30	291.74	314.18	336.62	359.06	381.50	403.94	426.39	448.83	471.27	493.71	516.15	538.59
6 6 in.	.....	.....	.....	.....	.....	.....	.....	.....	.....	316.05	340.36	364.67	388.98	413.30	437.60	461.92	486.23	510.54	534.85	559.16	583.47
7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	366 54	392.72	418 91	445.09	471 27	497.45	523.64	549.81	575.99	602.18	628.36
7 6 in.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	420.78	448.83	476.88	504.93	532.98	561.04	589.08	617.14	645.19	673.24
8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	478.75	508.67	538.59	568.51	598.44	628.36	658.28	688.20	718.12
8 6 in.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	540.46	572.25	604.05	635.84	667.63	699.42	731.21	763.00
9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	605.92	639.58	673.25	706.90	740.56	774.23	807.89
9 6 in.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	675.11	710.65	746.17	781.71	817.24	852.77
10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	748.05	785.45	822.86	860.26	897.66
10 6 in.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	824.73	864.00	903.26	942 56
11	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	905.14	946.27	987.43
11 6 in.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	989.29	1032.3
12	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1077 2

PIPE—DIMENSIONS AND PROPERTIES

DIMENSIONS							COUPLINGS			PROPERTIES		
Nom. Dia. In.	Outside Dia. In.	Inside Dia. In.	Thickness In.	Wt. per Ft., Lb. Plain Ends	Wt. per Ft., Lb. Thread & Cplg.	Threads per Inch	Outside Dia. In.	Length In.	Weight Lb.	I In.⁴	A In.²	r In.
STANDARD												
1/8	.405	.269	.068	.24	.25	27	.562	7/8	.03	.001	.072	.12
1/4	.540	.364	.088	.42	.43	18	.685	1	.04	.003	.125	.16
3/8	.675	.493	.091	.57	.57	18	.848	1 1/8	.07	.007	.167	.21
1/2	.840	.622	.109	.85	.85	14	1.024	1 3/8	.12	.017	.250	.26
3/4	1.050	.824	.113	1.13	1.13	14	1.281	1 5/8	.21	.037	.333	.33
1	1.315	1.049	.133	1.68	1.68	11 1/2	1.576	1 7/8	.35	.087	.494	.42
1 1/4	1.660	1.380	.140	2.27	2.28	11 1/2	1.950	2 1/8	.55	.195	.669	.54
1 1/2	1.900	1.610	.145	2.72	2.73	11 1/2	2.218	2 3/8	.76	.310	.799	.62
2	2.375	2.067	.154	3.65	3.68	11 1/2	2.760	2 5/8	1.23	.666	1.075	.79
2 1/2	2.875	2.469	.203	5.79	5.82	8	3.276	2 7/8	1.76	1.530	1.704	.95
3	3.500	3.068	.216	7.58	7.62	8	3.948	3 1/8	2.55	3.017	2.228	1.16
3 1/2	4.000	3.548	.226	9.11	9.20	8	4.591	3 5/8	4.33	4.788	2.680	1.34
4	4.500	4.026	.237	10.79	10.89	8	5.091	3 5/8	5.41	7.233	3.174	1.51
5	5.563	5.047	.258	14.62	14.81	8	6.296	4 1/8	9.16	15.16	4.300	1.88
6	6.625	6.065	.280	18.97	19.19	8	7.358	4 1/8	10.82	28.14	5.581	2.25
8	8.625	8.071	.277	24.70	25.00	8	9.420	4 5/8	15.84	63.35	7.265	2.95
8	8.625	7.981	.322	28.55	28.81	8	9.420	4 5/8	15.84	72.49	8.399	2.94
10	10.750	10.192	.279	31.20	32.00	8	11.721	6 1/8	33.92	125.4	9.178	3.70
10	10.750	10.136	.307	34.24	35.00	8	11.721	6 1/8	33.92	137.4	10.07	3.69
10	10.750	10.020	.365	40.48	41.13	8	11.721	6 1/8	33.92	160.7	11.91	3.67
12	12.750	12.090	.330	43.77	45.00	8	13.958	6 1/8	48.27	248.5	12.88	4.39
12	12.750	12.000	.375	49.56	50.71	8	13.958	6 1/8	48.27	279.3	14.38	4.38
EXTRA STRONG												
1/8	.405	.215	.095	.31	.32	27	.582	1 1/8	.05	.001	.093	.12
1/4	.540	.302	.119	.54	.54	18	.724	1 3/8	.07	.004	.157	.16
3/8	.675	.423	.126	.74	.75	18	.898	1 5/8	.13	.009	.217	.20
1/2	.840	.546	.147	1.09	1.10	14	1.085	1 7/8	.22	.020	.320	.25
3/4	1.050	.742	.154	1.47	1.49	14	1.316	2 1/8	.33	.045	.433	.32
1	1.315	.957	.179	2.17	2.20	11 1/2	1.575	2 3/8	.47	.106	.639	.41
1 1/4	1.660	1.278	.191	3.00	3.05	11 1/2	2.054	2 7/8	1.04	.242	.881	.52
1 1/2	1.900	1.500	.200	3.63	3.69	11 1/2	2.294	2 7/8	1.17	.391	1.068	.61
2	2.375	1.939	.218	5.02	5.13	11 1/2	2.870	3 5/8	2.17	.868	1.477	.77
2 1/2	2.875	2.323	.276	7.66	7.83	8	3.389	4 1/8	3.43	1.924	2.254	.92
3	3.500	2.900	.300	10.25	10.46	8	4.014	4 1/8	4.13	3.894	3.016	1.14
3 1/2	4.000	3.364	.318	12.51	12.82	8	4.628	4 5/8	6.29	6.280	3.678	1.31
4	4.500	3.826	.337	14.98	15.39	8	5.233	4 5/8	8.16	9.610	4.407	1.48
5	5.563	4.813	.375	20.78	21.42	8	6.420	5 1/8	12.87	20.67	6.112	1.84
6	6.625	5.761	.432	28.57	29.33	8	7.482	5 1/8	15.18	40.49	8.405	2.20
8	8.625	7.625	.500	43.39	44.72	8	9.596	6 1/8	26.63	105.7	12.76	2.88
10	10.750	9.750	.500	54.74	56.94	8	11.958	6 5/8	44.16	211.9	16.10	3.63
12	12.750	11.750	.500	65.42	68.02	8	13.958	6 5/8	51.99	361.5	19.24	4.34
DOUBLE-EXTRA STRONG												
1/2	.840	.252	.294	1.71	1.73	14	1.085	1 7/8	.22	.024	.504	.22
3/4	1.050	.434	.308	2.44	2.46	14	1.316	2 1/8	.33	.058	.718	.28
1	1.315	.599	.358	3.66	3.68	11 1/2	1.575	2 3/8	.47	.140	1.076	.36
1 1/4	1.660	.896	.382	5.21	5.27	11 1/2	2.054	2 7/8	1.04	.341	1.534	.47
1 1/2	1.900	1.100	.400	6.41	6.47	11 1/2	2.294	2 7/8	1.17	.568	1.885	.55
2	2.375	1.503	.436	9.03	9.14	11 1/2	2.870	3 5/8	2.17	1.311	2.656	.70
2 1/2	2.875	1.771	.552	13.70	13.87	8	3.389	4 1/8	3.43	2.871	4.028	.84
3	3.500	2.300	.600	18.58	18.79	8	4.014	4 1/8	4.13	5.992	5.466	1.05
3 1/2	4.000	2.728	.636	22.85	23.16	8	4.628	4 5/8	6.29	9.848	6.721	1.21
4	4.500	3.152	.674	27.54	27.95	8	5.233	4 5/8	8.16	15.28	8.101	1.37
5	5.563	4.063	.750	38.55	39.20	8	6.420	5 1/8	12.87	33.64	11.34	1.72
6	6.625	4.897	.864	53.16	53.92	8	7.482	5 1/8	15.18	66.33	15.64	2.06
8	8.625	6.875	.875	72.42	73.76	8	9.596	6 1/8	26.63	162.0	21.30	2.76

LARGE O. D. PIPE

Pipe 14" and larger is sold by actual O. S. diameter and thickness.
Sizes 14", 15", and 16" are available regularly in thicknesses varying by 1/16" from 1/4" to 1", inclusive.

STEEL PIPE COLUMNS

Allowable Concentric Loads in Kips

STANDARD PIPE

Unit Stress—American Institute of Steel Construction—1928

Nominal Size, In.		12	12	10	10	10	8	8	6	5	4	3½	3	2½	2
External Dia., In.		12.750	12.750	10.750	10.750	10.750	8.625	8.625	6.625	5.563	4.500	4.000	3.500	2.875	2.375
Thickness, In.		.375	.330	.365	.307	.279	.322	.277	.280	.258	.237	.226	.216	.203	.154
Effective Length in Feet	5	218.7	193.2	178.6	151.1	137.7	126.0	109.0	83.7	64.5	47.6	40.2	33.4	25.0	14.7
	6	218.7	193.2	178.6	151.1	137.7	126.0	109.0	83.7	64.5	47.6	40.2	33.1	23.2	13.3
	7	218.7	193.2	178.6	151.1	137.7	126.0	109.0	83.7	64.5	47.6	39.6	31.1	21.3	11.9
	8	218.7	193.2	178.6	151.1	137.7	126.0	109.0	83.7	64.5	46.6	37.5	29.1	19.5	10.6
	9	218.7	193.2	178.6	151.1	137.7	126.0	109.0	83.7	64.5	44.4	35.4	27.2	17.8	9.5
	10	218.7	193.2	178.6	151.1	137.7	126.0	109.0	83.7	63.1	42.2	33.3	25.2	16.2	8.5
	11	218.7	193.2	178.6	151.1	137.7	126.0	109.0	83.7	60.7	40.1	31.3	23.4	14.7	7.6
	12	218.7	193.2	178.6	151.1	137.7	126.0	109.0	81.8	58.3	37.9	29.3	21.7	13.4	6.8
	13	218.7	193.2	178.6	151.1	137.7	126.0	109.0	79.2	55.9	35.8	27.5	20.1	12.2	6.1
	14	218.7	193.2	178.6	151.1	137.7	126.0	109.0	76.6	53.6	33.8	25.7	18.6	11.1	
	15	218.7	193.2	178.6	151.1	137.7	125.1	108.4	74.0	51.2	31.9	24.0	17.2	10.2	
	16	218.7	193.2	178.6	151.1	137.7	122.2	106.0	71.4	49.0	30.0	22.5	16.0		
	17	218.7	193.2	178.6	151.1	137.7	119.3	103.4	68.8	46.8	28.3	21.0	14.8		
	18	218.7	193.2	178.6	151.1	137.7	116.3	100.9	66.3	44.6	26.7	19.7	13.8		
	19	218.7	193.2	176.6	149.5	136.5	113.3	98.3	63.8	42.6	25.2	18.5	12.1		
	20	218.7	193.2	173.3	146.8	134.0	110.3	95.8	61.4	40.6	23.7	17.3			
	21	218.7	193.2	169.9	144.0	131.4	107.3	93.2	59.1	38.7	22.4	16.2			
	22	218.3	193.1	166.6	141.2	128.9	104.4	90.6	56.8	36.9	21.2	15.2			
	23	215.0	190.2	163.2	138.4	126.3	101.4	88.1	54.6	35.2	20.0				
	24	211.6	187.1	159.8	135.5	123.7	98.6	85.6	52.5	33.5	18.9				
	25	208.2	184.1	156.4	132.7	121.1	95.8	83.2	50.4	32.0	17.9				
	26	204.7	181.1	153.1	129.8	118.5	93.8	80.8	48.4	30.6					
	27	201.2	178.1	149.7	127.0	115.9	90.2	78.4	46.6	29.2					
	28	197.8	174.9	146.3	124.1	113.3	87.6	76.1	44.7	27.8					
	29	194.3	171.9	143.1	121.4	110.8	84.9	73.9	43.0	26.6					
	30	190.8	168.9	139.8	118.6	108.4	82.5	71.7	41.5	25.4					
Area, In.^{2}		14.58	12.88	11.91	10.07	9.18	8.40	7.27	5.58	4.30	3.17	2.68	2.23	1.70	1.08
I, In.^{4}		279.3	248.5	160.7	137.4	125.9	72.5	63.4	28.1	15.2	7.23	4.79	3.02	1.53	0.666
r, In.		4.377	4.393	3.674	3.694	3.703	2.938	2.953	2.245	1.878	1.510	1.337	1.164	0.947	0.787
Weight, lb./ft.		49.56	43.77	40.48	34.24	31.20	28.55	21.70	18.97	14.62	10.79	9.11	7.58	5.79	3.65

Safe loads in accordance with A. I. S. C. Column Formula, maximum 15,000 pounds for ratios of l/r=60 and under.

Safe load values above upper zig-zag line are for ratios of l/r not over 60, those between zig-zag lines are for ratios up to 120 and those below lower zig-zag line are for ratios not over 200.

STEEL PIPE COLUMNS

Allowable Concentric Loads in Kips

EXTRA STRONG PIPE

Unit Stress—American Institute of Steel Construction—1928

Nominal Size, In.		12	10	8	6	5	4	3½	3	2½	2
External Dia., In.		12.750	10.750	8.625	6.625	5.563	4.500	4.000	3.500	2.875	2.375
Thickness, In.		.500	.500	.500	.432	.375	.337	.318	.300	.276	.218
Effective Length in Feet	5	288.6	241.5	191.4	126.1	91.7	66.1	55.2	45.2	32.8	19.9
	6	288.6	241.5	191.4	126.1	91.7	66.1	55.2	44.4	30.3	17.9
	7	288.6	241.5	191.4	126.1	91.7	66.1	53.9	41.7	27.8	16.0
	8	288.6	241.5	191.4	126.1	91.7	64.3	51.0	38.9	25.2	14.3
	9	288.6	241.5	191.4	126.1	91.7	61.2	48.0	36.2	23.0	12.7
	10	288.6	241.5	191.4	126.1	88.9	58.1	45.1	33.6	20.9	11.3
	11	288.6	241.5	191.4	126.1	85.5	55.0	42.3	31.1	19.0	10.1
	12	288.6	241.5	191.4	122.2	82.0	52.0	39.7	28.8	17.3	9.0
	13	288.6	241.5	191.4	118.2	78.6	49.0	37.0	26.6	15.7	
	14	288.6	241.5	191.4	114.2	75.2	46.2	34.6	24.5	14.3	
	15	288.6	241.5	188.7	110.2	71.8	43.5	32.3	22.7	13.0	
	16	288.6	241.5	184.2	106.2	68.5	40.9	30.1	21.0		
	17	288.6	241.5	179.6	102.3	65.3	38.5	28.1	19.5		
	18	288.6	241.5	174.9	98.4	62.2	36.3	26.3	18.1		
	19	228.6	237.6	170.3	94.6	59.3	34.2	24.6			
	20	288.6	233.1	165.7	91.0	56.5	32.2	23.0			
	21	288.6	228.5	161.0	87.4	53.8	30.3	21.5			
	22	287.1	223.9	156.5	83.9	51.2	28.6				
	23	282.6	219.3	152.0	80.6	48.8	27.1				
	24	278.2	214.6	147.6	77.4	46.5	25.7				
	25	273.6	210.0	143.3	74.3	44.4					
	26	268.9	205.4	139.0	71.3	42.3					
	27	264.3	200.8	134.8	68.5	40.4					
	28	259.7	196.3	130.6	65.8	38.6					
	29	255.0	191.8	126.7	63.2	36.8					
	30	250.3	187.2	122.9	60.7	35.1					
Area, in.^{2}		19.24	16.10	12.76	8.41	6.11	4.41	3.68	3.02	2.25	1.48
I, in.^{4}		361.5	212.0	105.7	40.5	20.7	9.61	6.28	3.89	1.92	0.870
r, in.		4.335	3.628	2.878	2.195	1.839	1.477	1.307	1.136	0.924	0.767
Weight, lb./ft.		65.42	54.74	43.39	28.57	20.78	14.98	12.51	10.25	7.66	5.02

Safe loads in accordance with A. I. S. C. Column Formula, maximum 15,000 pounds for ratios of $l/r = 60$ and under.

Safe load values above upper zig-zag line are for ratios of l/r not over 60, those between zig-zag lines are for ratios up to 120 and those below lower zig-zag line are for ratios not over 200.

HEATING SURFACE IN STANDARD PIPE

Length of Pipe in Ft.	Size of Pipe									
	¾	1	1¼	1½	2	2½	3	4	5	6
1	.275	.346	.434	.494	.622	.753	.916	1.175	1.455	1.739
2	.5	.7	.9	1.	1.2	1.5	1.8	2.4	2.9	3.5
3	.8	1.	1.3	1.5	1.9	2.3	2.7	3.5	4.4	5.2
4	1.1	1.4	1.7	2.	2.5	3.	3.6	4.7	5.8	7.
5	1.4	1.7	2.2	2.4	3.1	3.8	4.6	5.8	7.3	7.7
6	1.6	2.1	2.6	2.9	3.7	4.5	5.5	7.	8.7	10.5
7	1.9	2.4	3.	3.4	4.4	5.3	6.4	8.2	10.2	12.1
8	2.2	2.8	3.5	3.9	5.	6.	7.3	9.4	11.6	13.9
9	2.5	3.1	3.9	4.4	5.6	6.8	8.2	10.6	13.1	15.7
10	2.7	3.5	4.3	4.9	6.2	7.5	9.1	11.8	14.6	17.4
11	3.	3.8	4.8	5.4	6.8	8.3	10.	12.9	16.	19.1
12	3.3	4.1	5.2	5.9	7.5	9.	11.	14.1	17.4	20.9
13	3.6	4.5	5.6	6.4	8.1	9.8	11.9	15.3	18.9	22.6
14	3.8	4.8	6.1	6.9	8.7	10.5	12.8	16.5	20.3	24.3
15	4.1	5.2	6.5	7.4	9.3	11.3	13.7	17.6	21.8	26.1
16	4.4	5.5	6.9	7.9	10.	12.	14.6	18.8	23.2	27.8
17	4.7	5.9	7.4	8.4	10.6	12.8	15.5	20.	24.7	29.5
18	5.	6.2	7.8	8.9	11.2	13.5	16.5	21.2	26.2	31.3
19	5.2	6.6	8.3	9.4	11.8	14.3	17.4	22.3	27.6	33.1
20	5.5	6.9	8.7	9.9	12.5	15.	18.3	23.5	29.1	34.8
25	6.9	8.6	10.9	12.3	15.6	18.8	22.9	29.3	36.3	43.5
30	8.3	10.4	13.	14.8	18.7	22.5	27.5	35.3	43.6	52.1
35	9.6	12.1	15.2	17.3	21.8	26.3	32.	41.1	50.9	60.8
40	11.	13.8	17.4	19.8	24.9	30.1	36.6	47.	58.2	69.5
45	12.4	15.6	19.5	22.2	28.	33.8	41.2	52.9	65.5	78.2
50	13.8	17.3	21.7	24.7	31.1	37.6	45.8	58.7	72.7	87.
55	15.2	19.0	23.9	27.1	34.3	41.3	50.4	64.6	80.1	95.6
60	16.6	20.8	26.0	29.6	37.3	45.2	55.	70.5	87.3	104.3
65	18.0	22.6	28.2	32.1	40.5	48.8	59.5	76.4	94.5	112.9
70	19.4	24.2	30.4	34.6	43.5	52.7	64.1	82.3	101.9	121.7
75	20.7	26.0	32.6	37.1	46.6	56.5	68.7	88.1	109.1	130.4
80	22.	27.7	34.7	39.6	49.8	60.2	73.3	94.0	116.4	139.1
85	23.4	29.4	36.9	42.0	53.4	63.9	77.8	99.9	123.7	147.9
90	24.8	31.1	39.1	44.5	56.	67.8	82.4	105.8	130.9	156.5
95	26.2	32.9	41.2	46.9	59.6	71.5	87.2	111.6	138.2	165.2
100	27.5	34.3	43.4	49.4	62.2	75.3	91.6	117.5	145.5	173.9

EXPANSION AND CONTRACTION OF BODIES BY CHANGES IN TEMPERATURE

The linear coefficient of expansion of a body is the rate at which the unit of length changes, under constant pressure, with a change of one degree of temperature; the square surface coefficient of expansion is, approximately, two times, and the cubical or volumetric coefficient three times the linear coefficient of expansion. A bar, if not fixed, undergoes a change in length = *l*tn, where *l* is the length of the bar in inches, t the change in temperature in degrees, n the corresponding linear coefficient; if fixed at both ends, the internal stress per unit of area = tnE pounds per square inch, where E is the modulus of elasticity, and the total temperature stress = AtnE pounds, where A is the area of the cross section of the bar in square inches.

To find the change in length of a bar, due to a change in temperature, multiply the length of the bar by that change in degrees and by the coefficient for one degree.

LINEAR COEFFICIENTS OF EXPANSION FOR ONE DEGREE

Substance	Coefficient, n		Substance	Coefficient, n	
	Centigrade	Fahrenheit		Centigrade	Fahrenheit
Metals and Alloys			**Stone and Masonry**		
Aluminum, wrought	.0000231	.0000128	Ashlar masonry	.0000063	.0000035
Brass	.0000188	.0000104	Brick masonry	.0000055	.0000031
" wire	.0000193	.0000107	Cement, Portland	.0000107	.0000059
Bronze	.0000181	.0000101	Concrete	.0000143	.0000079
Copper	.0000168	.0000093	" masonry	.0000120	.0000067
German Silver	.0000183	.0000102	Granite	.0000084	.0000047
Gold	.0000150	.0000083	Limestone	.0000080	.0000044
Iron, cast, gray	.0000106	.0000059	Marble	.0000100	.0000056
" wrought	.0000120	.0000067	Plaster	.0000166	.0000092
" wire	.0000124	.0000069	Rubble masonry	.0000063	.0000035
Lead	.0000286	.0000159	Sandstone	.0000110	.0000061
Nickel	.0000126	.0000070	Slate	.0000104	.0000058
Platinum	.0000090	.0000050	**Timber**		
Platinum-Iridium, 15% Ir	.0000081	.0000045	Fir, parallel to fiber	.0000037	.0000021
Silver	.0000192	.0000107	Maple, parallel to fiber	.0000064	.0000036
Steel, cast	.0000110	.0000061	Oak, parallel to fiber	.0000049	.0000027
" hard	.0000132	.0000073	Pine, parallel to fiber	.0000054	.0000030
" medium	.0000120	.0000067	Fir, perpendicular to fiber	.000058	.000032
" soft	.0000110	.0000061	Maple, perpendicular to fiber	.000048	.000027
Tin	.0000210	.0000117	Oak, perpendicular to fiber	.000054	.000030
Zinc, rolled	.0000311	.0000173	Pine, perpendicular to fiber	.000034	.000019
Miscellaneous Solids			**Liquid Substances**	Volumetric Expan.	
Glass	.0000085	.0000047	Alcohol	.00104	.00058
Graphite	.0000079	.0000044	Acid, nitric	.00110	.00061
Gutta-percha	.0005980	.0003322	" sulphuric	.00063	.00035
Paraffin	.0002785	.0001547	Mercury	.00018	.00010
Porcelain	.0000036	.0000020	Oil, turpentine	.00090	.00050

EXPANSION OF WATER, MAXIMUM DENSITY = 1

C°	Volume	C°	Volume	C°	Volume	C°	Volume	C°	Volume	C°	Volume
0	1.000126	10	1.000257	30	1.004234	50	1.011877	70	1.022384	90	1.035829
4	1.000000	20	1.001732	40	1.007627	60	1.016954	80	1.029003	100	1.043116

TABLE OF EQUIVALENT OF DEGREES CENTIGRADE IN FAHRENHEIT

Degrees Centi-grade →	0	10	20	30	40	50	60	70	80	90
↓	Degrees Fahrenheit									
0	32	50	68	86	104	122	140	158	176	194
100	212	230	248	266	284	302	320	338	356	374
200	392	410	428	446	464	482	500	518	536	554
300	572	590	608	626	644	662	680	698	716	734
400	752	770	788	806	824	842	860	878	896	914
500	932	950	968	986	1004	1022	1040	1057	1076	1094
600	1112	1130	1148	1166	1184	1202	1220	1237	1256	1274
700	1292	1310	1328	1345	1364	1382	1400	1418	1436	1454
800	1472	1490	1508	1526	1544	1562	1580	1598	1616	1634
900	1652	1670	1688	1706	1724	1742	1760	1778	1796	1814
1000	1830	1850	1868	1886	1904	1922	1940	1958	1976	1994
1100	2012	2030	2048	2066	2084	2102	2120	2138	2156	2174
1200	2192	2210	2228	2246	2264	2282	2300	2318	2336	2354
1300	2372	2390	2408	2426	2444	2462	2480	2498	2516	2534
1400	2552	2570	2588	2606	2624	2642	2660	2678	2696	2714
1500	2732	2750	2768	2786	2804	2822	2840	2858	2876	2894
1600	2912	2930	2948	2966	2984	3002	3020	3038	3056	3074
1700	3092	3110	3128	3146	3164	3182	3200	3218	3236	3254
1800	3272	3290	3308	3326	3344	3362	3380	3398	3416	3434
1900	3452	3470	3488	3506	3524	3542	3560	3578	3596	3614
2000	3632	3650	3668	3686	3704	3722	3740	3758	3776	3794

THEORETICAL BURSTING PRESSURE—CYLINDRICAL SHELLS

Joint Efficiency—100 per cent

Tensile Strength of Steel—55,000 pounds per square inch

Inside Dia.	THICKNESS																				
	1/4	9/32	5/16	11/32	3/8	13/32	7/16	15/32	1/2	17/32	9/16	19/32	5/8	21/32	11/16	23/32	3/4	25/32	13/16	27/32	7/8
24	1146	1289	1432	1575	1718	1861	2005	2148	2292	....	....	....	....	....	....	....	....	....	....	....	....
26	1058	1190	1322	1452	1587	1718	1850	1984	2117	....	....	....	....	....	....	....	....	....	....	....	....
28	982	1104	1228	1350	1473	1596	1718	1841	1965	2086	2209	....	....	....	....	....	....	....	....	....	....
30	916	1030	1146	1260	1375	1489	1602	1718	1833	1947	2061	....	....	....	....	....	....	....	....	....	....
32	859	967	1074	1181	1289	1397	1502	1611	1719	1827	1934	2041	2148	....	....	....	....	....	....	....	....
34	809	910	1011	1111	1213	1314	1415	1517	1618	1718	1820	1921	2022	....	....	....	....	....	....	....	....
36	764	859	955	1050	1146	1241	1336	1432	1528	1623	1718	1814	1910	2004	2100	....	....	....	....	....	....
38	723	814	904	995	1085	1176	1266	1358	1446	1539	1629	1718	1808	1900	1990	....	....	....	....	....	....
40	687	773	859	945	1031	1117	1203	1290	1374	1460	1547	1633	1718	1805	1890	1975	2062	....	....	....	....
42	654	736	818	900	982	1067	1146	1228	1308	1391	1472	1556	1636	1718	1800	1882	1964	....	....	....	....
44	625	703	781	859	937	1015	1094	1171	1250	1328	1406	1485	1562	1640	1718	1796	1874	1952	2030	....	....
46	598	672	747	822	897	971	1046	1121	1196	1270	1344	1420	1494	1569	1644	1718	1794	1868	1942	....	....
48	573	644	716	788	859	931	1001	1073	1146	1218	1288	1361	1432	1503	1575	1647	1718	1790	1862	1933	2002
50	550	619	687	756	825	894	962	1031	1100	1169	1238	1307	1374	1444	1512	1581	1650	1718	1788	1856	1924
52	529	595	661	727	793	859	925	992	1058	1123	1190	1257	1322	1389	1453	1520	1586	1652	1718	1785	1850
54	509	573	636	700	764	827	891	955	1019	1082	1146	1210	1272	1338	1400	1464	1528	1591	1654	1718	1782
60	458	516	573	630	687	745	802	859	917	974	1032	1089	1146	1202	1260	1318	1375	1431	1490	1547	1603
66	417	469	521	573	625	677	729	782	834	886	938	990	1042	1093	1146	1198	1250	1301	1354	1407	1458
72	382	430	477	525	573	621	668	716	764	812	860	907	954	1002	1050	1098	1146	1193	1242	1290	1336
78	352	397	441	484	529	573	617	661	703	749	794	838	882	926	968	1013	1058	1101	1146	1190	1234
84	327	368	409	450	491	532	573	614	655	696	736	778	818	860	900	941	982	1022	1064	1105	1146
90	305	344	382	420	459	496	535	573	611	650	688	726	764	802	840	879	917	955	993	1031	1070
96	286	322	358	394	430	465	501	537	573	609	645	681	716	752	788	824	859	895	931	968	1002
102	270	303	337	371	405	438	472	506	539	573	607	641	674	708	742	775	810	843	876	910	944
108	254	287	318	350	382	414	445	478	509	541	573	605	636	669	700	732	764	796	827	860	891
114	241	272	302	332	362	392	422	453	483	513	543	573	603	634	664	694	724	754	784	814	844
120	229	258	286	315	344	372	401	430	458	487	516	545	573	602	630	659	687	716	745	774	802
126	218	246	273	300	328	355	382	409	436	464	491	518	546	573	600	628	655	683	710	737	764
132	208	234	260	287	312	339	365	391	417	443	469	495	521	547	573	599	625	651	677	704	729
138	199	224	249	274	299	324	349	374	398	424	449	474	498	524	548	573	598	623	648	673	698
144	191	215	239	262	287	310	334	358	382	406	430	454	478	501	525	549	573	597	621	645	668

The safe working pressure is found by dividing the above bursting pressures by the factor of safety and multiplying the quotient by the efficiency of the longitudinal joint. Example: Shell 60 in. diam. x ½ in. thick, factor of safety 5; butt and double strap joint, double riveted efficiency 81.3%: $\frac{917}{5} \times .813 = 149$ lbs.

USEFUL INFORMATION

TO DETERMINE THE SHELL THICKNESS OF A PRESSURE TANK

$$T = \frac{P \times R \times F.S.}{T.S. \times E}$$

P = Maximum allowable working pressure in pounds per square inch.
T. S. = Tensile strength of shell plates, in pounds per square inch of cross section.
E = Efficiency of longitudinal joint.
R = Radius = one half (½) the inside diameter in inches of the outside course of the shell or drum.
F. S. = Factor of Safety (generally considered to be 5).
T = Minimum thickness of shell plates in inches.

TO DETERMINE THE SHELL THICKNESS OF STAND PIPES, STORAGE TANKS, ETC.

$$T = \frac{H \times D \times G}{S \times E}$$

H = Distance down from water surface in feet.
D = Diameter of tank in feet.
S = Unit stress—assumed as 12,000 lbs. to 15,000 lbs. per square inch.
E = Efficiency, which depends on the design of the vertical joints, and should vary from 65% to 95%.
G = Specific gravity of liquid.

CONCRETE WALLS OR PIERS

The proper portion of ingredients required for supports for tanks is:

1 Cement, 2 Sand, 5 Stone

The ingredients required for 1 cubic yard of rammed concrete using stone 2½" and under are:

Cement 1.26 bbls.
Sand .48 cu. yd.
Stone .96 cu. yd.
1 cu. yd. Sand = 1.41 Tons
1 cu. yd. Stone = 1.2 Tons

Care should be taken that concrete in supporting walls or piers is thoroughly set and hardened before placing loads on same.

LIQUID MEASURE—UNITED STATES ONLY

Cubic Inch	Pints	Quarts	Gallons	Barrels	Hogshead
28.875	1.	0.5	0.125	0.003968	
57.75	2.	1.	0.25	0.007937	
231.	8.	4.	1.	0.031746	
7276.5	252.	126.	31.5	1.	0.5
14553.0	504.	252.	63.	2.	1.

The British Imperial gallon = 1.20032 U. S. gallons.

The United States standard unit for liquid measure is the gallon = 231 cu. in. = 8.33888 pounds, avoirdupois, of distilled water at 62° Fahr.

The English standard is the Imperial gallon = 277.2738 cu. in. = 10 pounds, avoirdupois, of distilled water at 62° Fahr.

FLAT STEEL RECTANGULAR PLATES

TO FIND THICKNESS OF PLATE REQUIRED

Pressure given—Based on Grashof's Formula

$$t = 0.62 \sqrt{\frac{W \times L \times l}{S(L^2 + l^2)}}$$

P = Load in lbs. per sq. in.
W = Total load in pounds
L = Long span of distance between supports in inches
l = Short span of distance between supports in inches
S = Fiber stress of steel in lbs. per sq. in.
t = Thickness of plate in inches

CIRCULAR FLAT PLATES

TO FIND THICKNESS OF PLATE REQUIRED

Use same notation given for rectangular plates

Based on Reuleaux's Formulae

$$t = 0.46 \sqrt{\frac{W}{S}}$$

These formulae are for plates firmly secured all around the edges, with the load uniformly distributed over the unsupported area.

UNIT TENSILE STRESS ON HOLLOW CYLINDRICAL TANK WALLS

Based on Boyd's Formula

Girth Seam

$$S = \frac{PD}{4t}$$

Longitudinal Seam

$$S = \frac{PD}{2t}$$

S = Tensile stress in lbs. per sq. in.
P = Working Pressure in lbs. per sq. in.
D = Dia. of tank in inches
t = Thickness of tank shell in inches

APPROXIMATE WEIGHTS OF VARIOUS METALS

To find the weight of various metals, multiply the contents in cubic inches by the number shown below; the result will be the approximate weight in pounds.

Iron	.27777	Brass	.3112	Tin	.26562
Steel	.28332	Lead	.41015	Aluminum	.09375
Copper	.32118	Zinc	.25318		

USEFUL INFORMATION

TO FIND:

The circumference of a circle multiply diameter by 3.1416.

The diameter of a circle multiply circumference by .31831.

The area of a circle multiply square of diameter by .7854.

Doubling the diameter of a circle increases its area four times.

The side of an equal square multiply diameter by .8862.

A gallon of water (U. S. Standard) weighs 8⅓ lbs. and contains 231 cubic inches.

A cubic foot of water contains 7.48 gallons, 1,728 cubic inches, and weighs 62.4 lbs.

Surface of sphere = circumference x diameter.

Surface of sphere = diameter^2 x 3.1416.

Surface of sphere = circumference^2 x .3183.

Volume of sphere = surface x 1/6 diameter.

Volume of sphere = diameter^3 x .5236.

Volume of sphere = radius^3 x 4.1888.

Volume of sphere = circumference^3 x .016887.

To find the pressure in pounds per square inch of a column of water multiply the height of the column in feet by .434.

Steam rising from water at its boiling point (212 degrees) has a pressure equal to the atmosphere (14.7 lbs. to the square inch).

A standard horsepower: The evaporation of 30 lbs. of water per hour from a feed water temperature of 100 degrees F. into steam at 70 lbs. gauge pressure. (Equivalent to 34½ lbs. from and at 212 degrees Fahr.)

TO FIND THE CAPACITY OF A TANK IN GALLONS

To find the capacity of any style tank: determine its contents in cu. inches and multiply by .004329 and the result will be in U. S. gallons.

For figuring capacity of cylindrical tanks having flat heads, square the diameter (inches), multiply by the length (inches) and multiply by .0034; the result will be in U. S. gallons.

Capacity in gallons of hemispherical tank bottom = 15.665 x r^3.

Area in square feet of hemispherical tank bottom = 1.57 x d^2.

WEIGHTS OF OILS AND OTHER LIQUIDS

As most storage tanks contain oils, water or other well-known liquids, we are appending a table of needed information covering the general line of liquids.

TABLE OF WEIGHTS

	Average Specific Gravity	Lbs. in 1 Gal.	Lbs. in. 1 Cu. Ft.
Alcohol 90%	.8228	6.85	51.43
Alcohol 95%	.8089	6.74	50.56
Asphaltum	1.4	11.68	87.3
Castor Oil	.9639	8.03	60.24
Cotton Seed Oil	.9302	7.75	58.14
Creosote Oil	1.07	8.94	66.8
Fish Oil	.9205	7.67	57.53
Gasoline	.6511	5.42	40.69
Kerosene Oil	.8000	6.66	50.00
Lard Oil	.9175	7.64	57.34
Linseed Oil, boiled	.9411	7.84	58.81
Linseed Oil, raw	.9299	7.75	58.12
Molasses (crude)	1.458	12.17	91.00
Muriatic Acid (HCl)	1.201	10.03	75.00
Naphtha	.717	6.00	44.88
Neatsfoot Oil	.9142	7.62	57.14
Nitric Acid (HNO_3) 91%	1.50	12.57	94.00
Petroleum (crude)	.88	7.36	55.00
Petroleum (refined)	.81	6.69	50.00
Pitch	1.07 to 1.15	9.23	69.00
Snow (fresh fallen)	.125	1.07	8.00
Sperm Oil	.8815	7.34	55.09
Sulphuric Acid (H_2SO_4) 87%	1.80	14.98	112.00
Tar	1.2	10.03	75.00
Water	1.000	8.33	62.50

BEARING PLATES

Safe Resistance in Thousands of Pounds

Wall Bearing, Inches	Bearing Plates		Pressure in Pounds per Square Inch									
	Length Inches	Width, Inches	75	100	125	150	175	200	250	300	350	400
4	4	4	1.2	1.6	2.0	2.4	2.8	3.2	4.0	4.8	5.6	6.4
4	4	6	1.8	2.4	3.0	3.6	4.2	4.8	6.0	7.2	8.4	9.6
4	4	8	2.4	3.2	4.0	4.8	5.6	6.4	8.0	9.6	11.2	12.8
6	6	6	2.7	3.6	4.5	5.4	6.3	7.2	9.0	10.8	12.6	14.4
6	6	8	3.6	4.8	6.0	7.2	8.4	9.6	12.0	14.4	16.8	19.2
6	6	10	4.5	6.0	7.5	9.0	10.5	12.0	15.0	18.0	21.0	24.0
8	8	8	4.8	6.4	8.0	9.6	11.2	12.8	16.0	19.2	22.4	25.6
8	8	10	6.0	8.0	10.0	12.0	14.0	16.0	20.0	24.0	28.0	32.0
8	8	12	7.2	9.6	12.0	14.4	16.8	19.2	24.0	28.8	33.6	38.4
10	10	10	7.5	10.0	12.5	15.0	17.5	20.0	25.0	30.0	35.0	40.0
10	10	12	9.0	12.0	15.0	18.0	21.0	24.0	30.0	36.0	42.0	48.0
10	10	14	10.5	14.0	17.5	21.0	24.5	28.0	35.0	42.0	49.0	56.0
12	12	12	10.8	14.4	18.0	21.6	25.2	28.8	36.0	43.2	50.4	57.6
12	12	14	12.6	16.8	21.0	25.2	29.4	33.6	42.0	50.4	58.8	67.2
12	12	16	14.4	19.2	24.0	28.8	33.6	38.4	48.0	57.6	67.2	76.8
14	14	14	14.7	19.6	24.5	29.4	34.3	39.2	49.0	58.8	68.6	78.4
14	14	16	16.8	22.4	28.0	33.6	39.2	44.8	56.0	67.2	78.4	89.6
14	14	18	18.9	25.2	31.5	37.8	44.1	50.4	63.0	75.6	88.2	100.8
14	14	20	21.0	28.0	35.0	42.0	49.0	56.0	70.0	84.0	98.0	112.0
16	16	16	19.2	25.6	32.0	38.4	44.8	51.2	64.0	76.8	89.6	102.4
16	16	18	21.6	28.8	36.0	43.2	50.4	57.6	72.0	86.4	100.8	115.2
16	16	20	24.0	32.0	40.0	48.0	56.0	64.0	80.0	96.0	112.0	128.0
16	16	22	26.4	35.2	44.0	52.8	61.6	70.4	88.0	105.6	123.2	140.8
18	18	18	24.3	32.4	40.5	48.6	56.7	64.8	81.0	97.2	113.4	129.6
18	18	20	27.0	36.0	45.0	54.0	63.0	72.0	90.0	108.0	126.0	144.0
18	18	22	29.7	39.6	49.5	59.4	69.3	79.2	99.0	118.8	138.6	158.4
18	18	24	32.4	43.2	54.0	64.8	75.6	86.4	108.0	129.6	151.2	172.8
20	20	20	30.0	40.0	50.0	60.0	70.0	80.0	100.0	120.0	140.0	160.0
20	20	22	33.0	44.0	55.0	66.0	77.0	88.0	110.0	132.0	154.0	176.0
20	20	24	36.0	48.0	60.0	72.0	84.0	96.0	120.0	144.0	168.0	192.0
20	20	26	39.0	52.0	65.0	78.0	91.0	104.0	130.0	156.0	182.0	208.0
22	22	22	36.3	48.4	60.5	72.6	84.7	96.8	121.0	145.2	169.4	193.6
22	22	24	39.6	52.8	66.0	79.2	92.4	105.6	132.0	158.4	184.8	211.2
22	22	26	42.9	57.2	71.5	85.8	100.1	114.4	143.0	171.6	200.2	228.8
22	22	28	46.2	61.6	77.0	92.4	107.8	123.2	154.0	184.8	215.6	246.4
24	24	24	43.2	57.6	72.0	86.4	100.8	115.2	144.0	172.8	201.6	230.4
24	24	26	46.8	62.4	78.0	93.6	109.2	124.8	156.0	187.2	218.4	249.6
24	24	28	50.4	67.2	84.0	100.8	117.6	134.4	168 0	201.6	235.2	268.8
24	24	30	54.0	72.0	90.0	108.0	126.0	144.0	180.0	216.0	252.0	288.0

STRESS IN THOUSANDS OF POUNDS PER SQUARE INCH

Metals and Alloys	Tension, Ultimate	Elastic Limit	Compres'n, Ultimate	Bending, Ultimate	Shearing, Ultimate	Modulus of Elasticity	Elongation, %
Aluminum, cast	15	6.5	12	.....	12	11,000,000	.....
Aluminum, bars, sheets	24–28	12–14	.....	.....	.....	.....	.....
Aluminum, wire, hard	30–65	16–30	.....	.....	.....	.....	.....
Aluminum, wire, annealed	20–35	14	.....	.....	.....	.....	.....
Aluminum, 2—7% Ni, Cu, Fe, etc	40–50	25	.....	.....	.....	.....	.....
Aluminum Bronze, 5% to 7½% Al	75	40	120	.....	.....	.....	.....
Aluminum Bronze, 10% Al	85–100	60	.....	.....	.....	.....	.....
Brass, 17% Zn	32.6	8.2	.....	23.2	.....	.....	26.7
Brass, 23% Zn	.....	7.6	42	22.3	.....	.....	35.8
Brass, 30% Zn	28.1	8.6	.....	26.9	.....	.....	20.7
Brass, 39% Zn	41.1	17.4	75	39	.....	.....	20.7
Brass, 50% Zn	31	17.9	117	33.5	.....	.....	5.0
Brass, cast, common	18–24	6	30	20	36	9,000,000	22
Brass, wire, hard	80	.....	.....	.....	.....	.....	.....
Brass, wire, annealed	50	16	.....	.....	.....	14,000,000	.....
Bronze, 8% Sn	28.5	19	42	43.7	.....	10,000,000	5.5
Bronze, 13% Sn	29.4	20	53	34.5	.....	.....	3.3
Bronze, 20% Sn	33	.....	78	56.7	.....	.....	0.04
Bronze, 24% Sn	22	22	114	32	.....	.....	.....
Bronze, 30% Sn	5.6	5.6	147	12.1	.....	.....	.....
Bronze, gun metal, 9 Cu, 1 Sn	25–55	10	.....	52	.....	10,000,000	.....
Bronze, Manganese, cast | 10% Sn	60	30	125	.....	.....	.....	.....
Bronze, Manganese, rolled | 2% Mn	100	80	.....	.....	.....	.....	.....
Bronze, Phosphorus, cast | 9% Sn	50	24	.....	.....	.....	.....	.....
Bronze, Phosphorus, wire | 1% P	100	.....	.....	.....	.....	.....	.....
Bronze, Silicon, cast, 3% Si	55	.....	.....	.....	.....	.....	.....
Bronze, Silicon, cast, 5% Si	75	.....	.....	.....	.....	.....	.....
Bronze, Silicon, wire	108	.....	.....	.....	.....	.....	.....
Bronze, Tobin, cast | 38% Zn	60	.....	.....	.....	.....	.....	.....
Bronze, Tobin, rolled | 1½% Sn	80	40	.....	.....	.....	4,500,000	35
Bronze, Tobin, cold rolled | ⅛% Pb	100	.....	.....	.....	.....	.....	.....
Copper, cast	25	6	40	22	30	10,000,000	.....
Copper, plates, rods, bolts	32–35	10	32	.....	.....	.....	.....
Copper, wire, hard	55–65	.....	.....	.....	.....	18,000,000	.....
Copper, wire, annealed	36	10	.....	.....	.....	15,000,000	.....
Delta Metal, cast | 55—60% Cu	45	.....	.....	.....	.....	.....	10
Delta Metal, plates | 38—40% Zn	68	.....	.....	.....	.....	16,600,000	17
Delta Metal, bars | 2— 4% Fe	85	.....	.....	.....	.....	.....	.....
Delta Metla, wire | 1— 2% Sn	100	.....	.....	.....	.....	.....	.....
German Silver, 17.2% Zn, 21.1% Ni	40.9	18.8	.....	.....	.....	.....	28.5
Gold, cast	20	4	.....	.....	.....	8,000,000	25
Gold, wire	30	.....	.....	.....	.....	.....	.....
Gold, copper, 5 Au, 1 Cu	50	.....	.....	.....	.....	.....	.....
Iron, Cast, common	15–18	6	80	30	18–20	12,000,000	.....
Iron, cast, gray	18–24	.....	.....	25–33	.....	.....	.....
Iron, cast, malleable	27–35	15–20	46	30	40	.....	.....

*See Specifications of the American Society for Testing Materials.

(*Continued on page 118*)

STRENGTH OF MATERIALS

STRESS IN THOUSANDS OF POUNDS PER SQUARE INCH

Metals and Alloys	Tension, Ultimate	Elastic Limit	Compres'n, Ultimate	Bending, Ultimate	Shearing, Ultimate	Modulus of Elasticity	Elongation, %
Iron, wrought, shapes	48	26	tensile	tensile	⅝ tensile	28,000,000	.....
Iron, wrought, bars	50	27	tensile	tensile	⅝ tensile	28,000,000	.....
Iron, wrought, wire, unannealed	80	.....	.....	.....	.....	15,000,000	.....
Iron, wrought, wire, annealed	60	27	.....	.....	.....	25,000,000	.....
Lead, cast	1.8	.....	.....	.....	.....	1,000,000	.....
Lead, pipe, wire	2.2–2.5	.....	.....	.....	.....	1,000,000	.....
Lead, rolled, sheets	3.3	.....	7.1	.....	.....	2,200,000	.....
Platinum, wire, unannealed	53	.....	.....	.....	.....	24,400,000	18
Platinum wire, annealed	32	.....	.....	.....	.....	.....	50
Silver, rolled	40	.....	.....	.....	.....	.....	.....
Steel, boiler plates*, fire box	55–65	½ tensile	tensile	tensile	¾ tensile	29,000,000	27.3–23.0
Steel, boiler plates*, flange plates	52–62	½ tensile	tensile	tensile	¾ tensile	29,000,000	28.8–24.2
Steel castings*, soft	60	27	tensile	tensile	¾ tensile	29,000,000	22.0
Steel, castings*, medium	70	31.5	tensile	tensile	¾ tensile	29,000,000	18.0
Steel, castings*, hard	80	36	tensile	tensile	¾ tensile	29,000,000	15.0
Steel, reinforcing bars*, plain, structural grade	55–70	33	tensile	tensile	¾ tensile	29,000,000	25.4–20.0
Steel, reinforcing bars*, plain, intermediate	70–85	40	tensile	tensile	¾ tensile	29,000,000	18.6–15.3
Steel, reinforcing bars*, plain, hard	80	50	tensile	tensile	¾ tensile	29,000,000	15.0
Steel, reinforcing bars*, deformed, structural grade	55–70	33	tensile	tensile	¾ tensile	29,000,000	22.7–17.9
Steel, reinforcing bars*, deformed, intermediate	70–85	40	tensile	tensile	¾ tensile	29,000,000	16.1–13.2
Steel, reinforcing bars*, deformed, hard	80	50	tensile	tensile	¾ tensile	29,000,000	12.5
Steel, reinforcing bars*, cold twisted	.....	55	tensile	tensile	¾ tensile	29,000,000	5.0
Steel, rivets*, boilers	45–55	½ tensile	tensile	tensile	¾ tensile	29,000,000	33.3–27.3
Steel, rivets*, bridges	46–56	½ tensile	tensile	tensile	¾ tensile	29,000,000	32.6–26.8
Steel, rivets*, buildings	46–56	½ tensile	tensile	tensile	¾ tensile	29,000,000	30.4–25.0
Steel, rivets*, cars	48–58	½ tensile	tensile	tensile	¾ tensile	29,000,000	31.3–25.9
Steel, rivets*, ships	55–65	½ tensile	tensile	tensile	¾ tensile	29,000,000	27.3–23.0
Steel Shapes, bridges	55–65	½ tensile	tensile	tensile	¾ tensile	29,000,000	27.3–23.0
Steel Shapes, buildings	55–65	½ tensile	tensile	tensile	¾ tensile	29,000,000	25.4–21.5
Steel Shapes, cars	50–65	½ tensile	tensile	tensile	¾ tensile	29,000,000	30.0–23.0
Steel Shapes, locomotives	55–65	½ tensile	tensile	tensile	¾ tensile	29,000,000	27.3–23.0
Steel Shapes, ships	58–68	½ tensile	tensile	tensile	¾ tensile	29,000,000	25.9–22.1
Steel Alloys, Nickel Steel*, 3.25% Ni	85–100	50	tensile	tensile	¾ tensile	29,000,000	17.6–15.0
Steel Alloys, Nickel shapes, plates, bars	70–80	45	tensile	tensile	¾ tensile	29,000,000	21.4–18.8
Steel Alloys, Nickel rivets	95–110	55	tensile	tensile	¾ tensile	29,000,000	15.8–13.6
Steel Alloys, Nickel eye bars, unannealed	90–105	52	tensile	tensile	¾ tensile	29,000,000	20.0
Steel Alloys, Nickel eye bars, annealed	60–68	37–38	tensile	tensile	¾ tensile	29,000,000	29.0–23.0
Steel Alloys, Copper Steel, 0.50% Cu	65–110	40–70	.....	.....	.....	.....	.....
Steel Springs, untempered	120	60	.....	.....	.....	.....	.....
Steel Wire, unannealed	80	40	.....	.....	.....	.....	.....
Steel Wire, annealed	200	95	.....	.....	.....	.....	.....
Steel Wire, bridge cable	3.5–4.6	1.5–1.8	6	4	.....	4,000,000	.....
Tin, cast	11	.....	.....	.....	.....	.....	.....
Tin, antimony, 10 Sn, 1 Sb	4–6	4	18	7	.....	13,000,000	.....
Zinc, cast	7–16	.....	.....	.....	.....	.....	.....
Zinc, rolled sheets							

*See Specifications of the American Society for Testing Materials.

PROPERTIES OF ELEMENTS AND METAL COMPOSITIONS

Elements	Symbol	Density (Specific Gravity)	Weight Per Cubic Foot	Specific Heat	Melting Point	
					Degrees Centigrade	Degrees Fahrenheit
Aluminum	Al	2.7	166.7	0.212	658.7	1217.7
Antimony	Sb	6.69	418.3	0.049	630	1166
Armco Iron	.....	7.9	490.0	0.115	1535	2795
Carbon	C	2.34	219.1	0.113	3600	6512
Chromium	Cr	6.92	431.9	0.104	1615	3034
Columbium	Cb	7.06	452.54	.....	1700	3124
Copper	Cu	8.89	555.6	0.092	1083	1981.4
Gold	Au	19.33	1205.0	0.032	1063	1946
Hydrogen	H	0.070*	0.00533	.....	−259	−434.2
Iridium	Ir	22.42	1400.0	0.032	2300	4172
Iron	Fe	7.865	490.9	0.115	1530	2786
Lead	Pb	11.37	708.5	0.030	327	621
Manganese	Mn	7.4	463.2	0.111	1260	2300
Mercury	Hg	13.55	848.84	0.033	−38.7	−37.6
Nickel	Ni	8.80	555.6	0.109	1452	2645.6
Nitrogen	N	0.97*	.063	.....	−210	−346
Oxygen	O	1.10*	.0866	.....	−218	−360
Phosphorus	P	1.83	146.1	0.19	44	111.2
Platinum	Pt	21.45	1336.0	0.032	1755	3191
Potassium	K	0.87*	54.3	0.170	62.3	144.1
Silicon	Si	2.49	131.1	0.175	1420	2588
Silver	Ag	10.5	655.5	0.055	960.5	1761
Sodium	Na	0.971	60.6	0.253	97.5	207.5
Sulphur	S	1.95	128.0	0.173	119.2	246
Tin	Sn	7.30	455.7	0.054	231.9	449.5
Titanium	Ti	5.3	218.5	0.110	1795	3263
Tungsten	W	17.5	1186.0	0.034	3000	5432
Uranium	U	18.7	1167.0	0.028	.....	.....
Vanadium	V	6.0	343.3	0.115	1720	3128
Zinc	Zn	7.19	443.2	0.093	419	786.2
Bronze (90 Cu 10 Sn)	.....	8.78	548.0	.....	850–1000	1562–1832
Brass (90 Cu 10 Zn)	.....	8.60	540.0	.....	1020–1030	1868–1886
Brass (70 Cu 30 Zn)	.....	8.44	527.0	.....	900–940	1652–1724
Cast Pig Iron	.....	7.1	443.2	.....	1100–1250	2012–2282
Open Hearth Steel	.....	7.8	486.9	.....	1350–1530	2462–2786
Wrought Iron Bars	.....	7.8	486.9	.....	1530	2786

*Density compared with air.

SAFE BEARING VALUES OF DIFFERENT FOUNDATION SOILS

Material	Tons per Sq. Ft.
Granite rock formation	30
Limestone, compact beds	25
Sandstone, compact beds	20
Shale formation or soft friable rock	8–10
Gravel and sand, compact	6–10
Gravel, dry and coarse, packed and confined	6
Gravel and sand, mixed with dry clay	4–6
Clay, very dry and in thick beds	4
Clay, moderately dry and in thick beds	3
Clay, soft	1–1½
Sand, compact, well-cemented and confined	4
Sand, clean and dry, in natural beds and confined	2
Earth, solid, dry, and in natural beds	4

SQUARE AND ROUND BARS

WEIGHT AND AREA

Size Inches	Weight Lb. per Foot		Area Square Inches		Size Inches	Weight Lb. per Foot		Area Square Inches	
	■	●	▨	◍		■	●	▨	◍
0					3	30.60	24.03	9.000	7.069
1/16	.013	.010	.0039	.0031	1/16	31.89	25.05	9.379	7.366
1/8	.053	.042	.0156	.0123	1/8	33.20	26.08	9.766	7.670
3/16	.120	.094	.0352	.0276	3/16	34.54	27.13	10.160	7.980
1/4	.213	.167	.0625	.0491	1/4	35.91	28.21	10.563	8.296
5/16	.332	.261	.0977	.0767	5/16	37.31	29.30	10.973	8.618
3/8	.478	.376	.1406	.1105	3/8	38.73	30.42	11.391	8.946
7/16	.651	.511	.1914	.1503	7/16	40.18	31.55	11.816	9.281
1/2	.850	.668	.2500	.1963	1/2	41.65	32.71	12.250	9.621
9/16	1.076	.845	.3164	.2485	9/16	43.15	33.89	12.691	9.968
5/8	1.328	1.043	.3906	.3068	5/8	44.68	35.09	13.141	10.321
11/16	1.607	1.262	.4727	.3712	11/16	46.23	36.31	13.598	10.680
3/4	1.913	1.502	.5625	.4418	3/4	47.81	37.55	14.063	11.045
13/16	2.245	1.763	.6602	.5185	13/16	49.42	38.81	14.535	11.416
7/8	2.603	2.044	.7656	.6013	7/8	51.05	40.10	15.016	11.793
15/16	2.988	2.347	.8789	.6903	15/16	52.71	41.40	15.504	12.177
1	3.400	2.670	1.0000	.7854	4	54.40	42.73	16.000	12.566
1/16	3.838	3.015	1.1289	.8866	1/16	56.11	44.07	16.504	12.962
1/8	4.303	3.380	1.2656	.9940	1/8	57.85	45.44	17.016	13.364
3/16	4.795	3.766	1.4102	1.1075	3/16	59.62	46.83	17.535	13.772
1/4	5.313	4.172	1.5625	1.2272	1/4	61.41	48.23	18.063	14.186
5/16	5.857	4.600	1.7227	1.3530	5/16	63.23	49.66	18.598	14.607
3/8	6.428	5.049	1.8906	1.4849	3/8	65.08	51.11	19.141	15.033
7/16	7.026	5.518	2.0664	1.6230	7/16	66.95	52.58	19.691	15.466
1/2	7.650	6.008	2.2500	1.7671	1/2	68.85	54.07	20.250	15.904
9/16	8.301	6.519	2.4414	1.9175	9/16	70.78	55.59	20.816	16.349
5/8	8.978	7.051	2.6406	2.0739	5/8	72.73	57.12	21.391	16.800
11/16	9.682	7.604	2.8477	2.2365	11/16	74.71	58.67	21.973	17.257
3/4	10.413	8.178	3.0625	2.4053	3/4	76.71	60.25	22.563	17.721
13/16	11.170	8.773	3.2852	2.5802	13/16	78.74	61.85	23.160	18.190
7/8	11.953	9.388	3.5156	2.7612	7/8	80.80	63.46	23.766	18.665
15/16	12.763	10.024	3.7539	2.9483	15/16	82.89	65.10	24.379	19.147
2	13.600	10.681	4.0000	3.1416	5	85.00	66.76	25.000	19.635
1/16	14.463	11.359	4.2539	3.3410	1/16	87.14	68.44	25.629	20.129
1/8	15.353	12.058	4.5156	3.5466	1/8	89.30	70.14	26.266	20.629
3/16	16.270	12.778	4.7852	3.7583	3/16	91.49	71.86	26.910	21.135
1/4	17.213	13.519	5.0625	3.9761	1/4	93.71	73.60	27.563	21.648
5/16	18.182	14.280	5.3477	4.2000	5/16	95.96	75.36	28.223	22.166
3/8	19.178	15.062	5.6406	4.4301	3/8	98.23	77.15	28.891	22.691
7/16	20.201	15.866	5.9414	4.6664	7/16	100.53	78.95	29.566	23.221
1/2	21.250	16.690	6.2500	4.9087	1/2	102.85	80.78	30.250	23.758
9/16	22.326	17.534	6.5664	5.1572	9/16	105.20	82.62	30.941	24.301
5/8	23.428	18.400	6.8906	5.4119	5/8	107.58	84.49	31.641	24.850
11/16	24.557	19.287	7.2227	5.6727	11/16	109.98	86.38	32.348	25.406
3/4	25.713	20.195	7.5625	5.9396	3/4	112.41	88.29	33.063	25.967
13/16	26.895	21.123	7.9102	6.2126	13/16	114.87	90.22	33.785	26.535
7/8	28.103	22.072	8.2656	6.4918	7/8	117.35	92.17	34.516	27.109
15/16	29.338	23.042	8.6289	6.7771	15/16	119.86	94.14	35.254	27.688
3	30.600	24.033	9.0000	7.0686	6	122.40	96.13	36.000	28.274

SQUARE AND ROUND BARS
WEIGHT AND AREA

Size Inches	Weight Lb. per Foot		Area Square Inches		Size Inches	Weight Lb. per Foot		Area Square Inches	
	■	●	□	◎		■	●	□	◎
6	122.40	96.13	36.000	28.274	9	275.40	216.30	81.000	63.617
1/16	124.96	98.15	36.754	28.866	1/16	279.24	219.31	82.129	64.504
1/8	127.55	100.18	37.516	29.465	1/8	283.10	222.35	83.266	65.397
3/16	130.17	102.23	38.285	30.069	3/16	286.99	225.41	84.410	66.296
1/4	132.81	104.31	39.063	30.680	1/4	290.91	228.48	85.563	67.201
5/16	135.48	106.41	39.848	31.296	5/16	294.86	231.58	86.723	68.112
3/8	138.18	108.53	40.641	31.919	3/8	298.83	234.70	87.891	69.029
7/16	140.90	110.66	41.441	32.548	7/16	302.83	237.84	89.066	69.953
1/2	143.65	112.82	42.250	33.183	1/2	306.85	241.00	90.250	70.882
9/16	146.43	115.00	43.066	33.824	9/16	310.90	244.18	91.441	71.818
5/8	149.23	117.20	43.891	34.472	5/8	314.98	247.38	92.641	72.760
11/16	152.06	119.43	44.723	35.125	11/16	319.08	250.61	93.848	73.708
3/4	154.91	121.67	45.563	35.785	3/4	323.21	253.85	95.063	74.662
13/16	157.79	123.93	46.410	36.450	13/16	327.37	257.12	96.285	75.622
7/8	160.70	126.22	47.266	37.122	7/8	331.55	260.40	97.516	76.589
15/16	163.64	128.52	48.129	37.800	15/16	335.76	263.71	98.754	77.561
7	166.60	130.85	49.000	38.485	10	340.00	267.04	100.000	78.540
1/16	169.59	133.19	49.879	39.175	1/16	344.26	270.38	101.254	79.525
1/8	172.60	135.56	50.766	39.871	1/8	348.55	273.75	102.516	80.516
3/16	175.64	137.95	51.660	40.574	3/16	352.87	277.14	103.785	81.513
1/4	178.71	140.36	52.563	41.282	1/4	357.21	280.55	105.063	82.516
5/16	181.81	142.79	53.473	41.997	5/16	361.58	283.99	106.348	83.525
3/8	184.93	145.24	54.391	42.718	3/8	365.98	287.44	107.641	84.541
7/16	188.07	147.71	55.316	43.445	7/16	370.40	290.91	108.941	85.563
1/2	191.25	150.21	56.250	44.179	1/2	374.85	294.41	110.250	86.590
9/16	194.45	152.72	57.191	44.918	9/16	379.33	297.92	111.566	87.624
5/8	197.68	155.26	58.141	45.664	5/8	383.83	301.46	112.891	88.664
11/16	200.93	157.81	59.098	46.415	11/16	388.36	305.02	114.223	89.710
3/4	204.21	160.39	60.063	47.173	3/4	392.91	308.59	115.563	90.763
13/16	207.52	162.99	61.035	47.937	13/16	397.49	312.19	116.910	91.821
7/8	210.85	165.60	62.016	48.707	7/8	402.10	315.81	118.266	92.886
15/16	214.21	168.24	63.004	49.483	15/16	406.74	319.45	119.629	93.957
8	217.60	170.90	64.000	50.265	11	411.40	323.11	121.000	95.033
1/16	221.01	173.58	65.004	51.054	1/16	416.09	326.80	122.379	96.116
1/8	224.45	176.29	66.016	51.849	1/8	420.80	330.50	123.766	97.205
3/16	227.92	179.01	67.035	52.649	3/16	425.54	334.22	125.160	98.301
1/4	231.41	181.75	68.063	53.456	1/4	430.31	337.97	126.563	99.402
5/16	234.93	184.52	69.098	54.269	5/16	435.11	341.73	127.973	100.510
3/8	238.48	187.30	70.141	55.088	3/8	439.93	345.52	129.391	101.623
7/16	242.05	190.11	71.191	55.914	7/16	444.78	349.33	130.816	102.743
1/2	245.65	192.93	72.250	56.745	1/2	449.65	353.16	132.250	103.869
9/16	249.28	195.78	73.316	57.583	9/16	454.55	357.00	133.691	105.001
5/8	252.93	198.65	74.391	58.426	5/8	459.48	360.87	135.141	106.139
11/16	256.61	201.54	75.473	59.276	11/16	464.43	364.76	136.598	107.284
3/4	260.31	204.45	76.563	60.132	3/4	469.41	368.68	138.063	108.434
13/16	264.04	207.38	77.660	60.994	13/16	474.42	372.61	139.535	109.591
7/8	267.80	210.33	78.766	61.863	7/8	479.45	376.56	141.016	110.754
15/16	271.59	213.31	79.879	62.737	15/16	484.51	380.54	142.504	111.923
9	275.40	216.30	81.000	63.617	12	489.60	384.53	144.000	113.098

TOTAL PRESSURE IN LBS. OF LIQUID (S. G. 1) ON VERTICAL PLANE 1 FT. WIDE

Ft. \ In.	0	1	2	3	4	5
0	0.00	0.22	0.87	1.95	3.47	5.42
1	31.21	36.63	42.48	48.77	55.49	62.64
2	124.85	135.47	146.52	158.01	169.93	182.29
3	280.91	296.73	312.99	329.68	346.81	364.36
4	499.40	520.42	541.88	563.78	586.10	608.86
5	780.31	806.34	833.20	860.29	887.82	915.78
6	1,123.65	1,155.08	1,186.94	1,219.24	1,251.97	1,285.13
7	1,529.94	1,566.04	1,603.11	1,640.61	1,678.54	1,716.90
8	1,997.00	2,039.43	2,081.70	2,124.40	2,167.53	2,211.10
9	2,528.21	2,575.25	2,622.72	2,670.62	2,718.96	2,767.72
10	3,121.25	3,173.49	3,226.16	3,279.26	3,332.80	3,386.77
11	3,776.71	3,834.15	3,892.02	3,950.33	4,009.07	4,068.25
12	4,494.60	4,557.24	4,620.32	4,683.83	4,747.77	4,812.14
13	5,274.91	5,342.76	5,411.03	5,479.74	5,548.89	5,618.47
14	6,117.65	6,190.70	6,264.17	6,338.09	6,412.43	6,487.22
15	7,022.81	7,101.06	7,179.74	7,258.86	7,338.41	7.418.39
16	7,990.40	8,073.85	8,157.73	8,242.05	8,326.80	8,411.98
17	9,020.41	9,109.07	9,198.15	9,287.67	9,377.62	9,468.01
18	10,112.85	10,206.70	10,300.99	10,395.71	10,490.87	10,586.46
19	11,267.71	11,366.77	11,466.26	11,566.18	11,666.45	11,767.33
20	12,485.00	12,589.26	12,693.95	12,799.08	12,904.63	13,010.63
21	13,764.71	13,874.17	13,984.07	14,094.39	14,205.16	14,316.35
22	15,106.85	15,221.51	15,336.61	15,452.14	15,568.10	15,684.50
23	16,511.41	16,631.28	16,751.57	16,872.31	16,993.47	17,115.07
24	17,978.40	18,103.47	18,228.97	18,354.90	18,481.27	18,608.07
25	19,507.81	19,638.08	19,768.78	19,899.92	20,031.49	20,163.49
26	21,099.65	21,235.12	21,371.02	21,507.36	21,644.13	21,781.34
27	22,753.91	22,894.59	23,035.69	23,177.27	23,319.21	23,461.61
28	24,470.60	24,616.48	24,762.78	24,909.53	25,056.70	25,204.31
29	26,249.71	26,400.79	26,557.30	26,704.24	26,856.62	27,009.43
30	28,091.25	28,247.53	28,404.24	28,561.39	28,718.97	28,876.98

TOTAL PRESSURE IN LBS. OF LIQUID (S. G. 1) ON VERTICAL PLANE 1 FT. WIDE

In. / Ft.	6	7	8	9	10	11
0	7.80	10.62	13.87	17.56	21.68	26.23
1	70.23	78.25	86.70	95.59	104.91	114.67
2	195.08	208.30	221.96	236.04	250.57	265.52
3	382.35	400.78	419.63	438.93	458.65	478.81
4	632.05	655.68	679.74	704.23	729.16	754.52
5	944.18	973.01	1,002.27	1,031.97	1,062.09	1,092.65
6	1,318.73	1,352.76	1,387.22	1,422.12	1,457.45	1,493.22
7	1,755.70	1,794.93	1,834.60	1,874.70	1,915.23	1,956.20
8	2,255.10	2,299.54	2,344.41	2,389.71	2,435.44	2,481.61
9	2,816.93	2,866.57	2,916.63	2,967.14	3,018.07	3,069.45
10	3,441.18	3,496.02	3,551.29	3,606.99	3,663.13	3,719.71
11	4,127.85	4,187.89	4,248.36	4,309.28	4,370.62	4,432.39
12	4,876.95	4,942.20	5,007.87	5,073.98	5,140.52	5,207.50
13	5,688.48	5,758.92	5,829.80	5,901.11	5,972.86	6,045.04
14	6,562.43	6,638.07	6,714.16	6,790.67	6,867.62	6,945.00
15	7,498.80	7,579.65	7,660.93	7,742.65	7,824.17	7,907.38
16	8,497.60	8,583.65	8,670.14	8,757.06	8,844.41	8,932.19
17	9,558.83	9,650.08	9,741.77	9,833.89	9,926.44	10,019.43
18	10,682.48	10,778.93	10,875.82	10,973.14	11,070.90	11,169.09
19	11,868.55	11,970.21	12,072.30	12,174.83	12,277.78	12,381.17
20	13,117.05	13,223.91	13,331.21	13,438.93	13,547.09	13,655.68
21	14,427.98	14,540.04	14,652.53	14,765.46	14,878.82	14,992.62
22	15,801.33	15,918.59	16,036.29	16,154.42	16,272.98	16,391.98
23	17,237.10	17,359.37	17,482.47	17,605.80	17,729.57	17,853.77
24	18,735.30	18,862.97	18,991.07	19,119.61	19,248.57	19,377.98
25	20,295.93	20,428.80	20,562.10	20,695.84	20,830.01	20,964.61
26	21,918.98	22,057.05	22,195.56	22,334.49	22,473.87	22,613.67
27	23,604.45	23,747.73	23,891.43	24,035.58	24,180.15	24,325.16
28	25,352.35	25,500.83	25,649.74	25,799.08	25,948.86	26,099.07
29	27,162.68	27,316.36	27,470.47	27,625.01	27,779.99	27,935.40
30	29,035.43	29,194.31	29,353.62	29,513.37	29,673.55	29,834.17

DECIMALS OF A FOOT FOR INCHES AND FRACTIONS OF AN INCH

Inch	0″	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″
0	0	.0833	.1667	.2500	.3333	.4166	.5000	.5833	.6667	.7500	.8333	.9166
1/64	.0013	.0846	.1680	.2513	.3346	.4179	.5013	.5846	.6680	.7513	.8346	.9179
1/32	.0026	.0859	.1693	.2526	.3359	.4192	.5026	.5859	.6693	.7526	.8359	.9192
3/64	.0039	.0872	.1706	.2539	.3372	.4205	.5039	.5872	.6706	.7539	.8372	.9205
1/16	.0052	.0885	.1719	.2552	.3385	.4219	.5052	.5885	.6719	.7552	.8385	.9218
5/64	.0065	.0898	.1732	.2565	.3398	.4232	.5065	.5898	.6732	.7565	.8398	.9231
3/32	.0078	.0911	.1745	.2578	.3411	.4245	.5078	.5911	.6745	.7578	.8411	.9244
7/64	.0091	.0924	.1758	.2591	.3424	.4258	.5091	.5924	.6752	.7591	.8424	.9257
1/8	.0104	.0937	.1771	.2604	.3437	.4271	.5104	.5937	.6771	.7604	.8437	.9270
9/64	.0117	.0950	.1784	.2617	.3450	.4284	.5117	.5950	.6784	.7617	.8450	.9283
5/32	.0130	.0963	.1797	.2630	.3463	.4297	.5130	.5963	.6797	.7630	.8463	.9296
11/64	.0143	.0977	.1810	.2643	.3476	.4310	.5143	.5976	.6810	.7643	.8476	.9309
3/16	.0156	.0990	.1823	.2656	.3489	.4323	.5156	.5989	.6823	.7656	.8489	.9322
13/64	.0169	.1003	.1836	.2669	.3502	.4336	.5169	.6002	.6836	.7669	.8502	.9335
7/32	.0182	.1016	.1849	.2682	.3515	.4349	.5182	.6015	.6849	.7682	.8515	.9348
15/64	.0195	.1029	.1862	.2695	.3528	.4362	.5195	.6028	.6862	.7695	.8528	.9361
1/4	.0208	.1042	.1875	.2708	.3541	.4375	.5208	.6041	.6875	.7708	.8541	.9374
17/64	.0221	.1055	.1888	.2721	.3554	.4388	.5221	.6054	.6888	.7721	.8554	.9387
9/32	.0234	.1068	.1901	.2734	.3567	.4401	.5234	.6067	.6901	.7734	.8567	.9400
19/64	.0247	.1081	.1914	.2747	.3581	.4414	.5247	.6080	.6914	.7747	.8580	.9413
5/16	.0260	.1094	.1927	.2760	.3594	.4427	.5260	.6093	.6927	.7760	.8593	.9426
21/64	.0273	.1107	.1940	.2773	.3607	.4440	.5273	.6106	.6940	.7773	.8606	.9440
11/32	.0286	.1120	.1953	.2786	.3620	.4453	.5286	.6119	.6953	.7786	.8619	.9453
23/64	.0299	.1133	.1966	.2799	.3633	.4466	.5299	.6132	.6966	.7799	.8632	.9466
3/8	.0312	.1146	.1979	.2812	.3646	.4479	.5312	.6145	.6979	.7812	.8645	.9479
25/64	.0325	.1159	.1992	.2825	.3659	.4492	.5325	.6158	.6992	.7825	.8658	.9492
13/32	.0339	.1172	.2005	.2838	.3672	.4505	.5338	.6171	.7005	.7838	.8671	.9505
27/64	.0352	.1185	.2018	.2851	.3685	.4518	.5351	.6185	.7018	.7851	.8684	.9518
7/16	.0365	.1198	.2031	.2864	.3698	.4531	.5364	.6198	.7031	.7864	.8697	.9531
29/64	.0378	.1211	.2044	.2877	.3711	.4544	.5377	.6211	.7044	.7877	.8710	.9544
15/32	.0391	.1224	.2057	.2890	.3724	.4557	.5390	.6224	.7057	.7890	.8723	.9557
31/64	.0404	.1237	.2070	.2903	.3737	.4570	.5403	.6237	.7070	.7903	.8736	.9570
1/2	.0417	.1250	.2083	.2916	.3750	.4583	.5416	.6250	.7083	.7916	.8749	.9583
33/64	.0430	.1263	.2096	.2930	.3763	.4596	.5429	.6263	.7096	.7929	.8762	.9596
17/32	.0443	.1276	.2109	.2943	.3776	.4609	.5442	.6276	.7109	.7942	.8775	.9609
35/64	.0456	.1289	.2122	.2956	.3789	.4622	.5455	.6289	.7122	.7955	.8789	.9622
9/16	.0469	.1302	.2135	.2969	.3802	.4635	.5468	.6302	.7135	.7968	.8802	.9635
37/64	.0482	.1315	.2148	.2982	.3815	.4648	.5481	.6315	.7148	.7981	.8815	.9648
19/32	.0495	.1328	.2161	.2995	.3828	.4661	.5494	.6328	.7161	.7994	.8828	.9661
39/64	.0508	.1341	.2174	.3008	.3841	.4674	.5507	.6341	.7174	.8007	.8841	.9674
5/8	.0521	.1354	.2187	.3021	.3854	.4687	.5520	.6354	.7187	.8020	.8854	.9687
41/64	.0534	.1367	.2200	.3034	.3867	.4700	.5534	.6367	.7200	.8033	.8867	.9700
21/32	.0547	.1380	.2213	.3047	.3880	.4713	.5547	.6380	.7213	.8046	.8880	.9713
43/64	.0560	.1393	.2226	.3060	.3893	.4726	.5560	.6393	.7226	.8059	.8893	.9726
11/16	.0573	.1406	.2239	.3073	.3906	.4739	.5573	.6406	.7239	.8072	.8906	.9739
45/64	.0586	.1419	.2252	.3086	.3919	.4752	.5586	.6419	.7252	.8085	.8919	.9752
23/32	.0599	.1432	.2265	.3099	.3932	.4765	.5599	.6432	.7265	.8098	.8932	.9765
47/64	.0612	.1445	.2279	.3112	.3945	.4778	.6612	.6445	.7278	.8111	.8945	.9778
3/4	.0625	.1458	.2292	.3125	.3958	.4791	.5625	.6458	.7292	.8124	.8958	.9791
49/64	.0638	.1471	.2305	.3138	.3971	.4804	.5638	.6471	.7304	.8138	.8971	.9804
25/32	.0651	.1484	.2318	.3151	.3984	.4817	.5651	.6484	.7317	.8151	.8984	.9817
51/64	.0664	.1497	.2331	.3164	.3997	.4830	.5664	.6497	.7330	.8164	.8997	.9830
13/16	.0677	.1510	.2344	.3177	.4010	.4843	.5677	.6510	.7343	.8177	.9010	.9843
53/64	.0690	.1523	.2357	.3190	.4023	.4856	.5690	.6523	.7356	.8190	.9023	.9856
27/32	.0703	.1536	.2370	.3203	.4036	.4869	.5703	.6536	.7369	.8203	.9036	.9869
55/64	.0716	.1549	.2383	.3216	.4049	.4883	.5716	.6549	.7382	.8216	.9049	.9882
7/8	.0729	.1562	.2396	.3229	.4062	.4896	.5729	.6562	.7395	.8229	.9062	.9895
57/64	.0742	.1575	.2409	.3242	.4075	.4909	.5742	.6575	.7408	.8242	.9075	.9908
29/32	.0755	.1588	.2422	.3255	.4088	.4922	.5755	.6588	.7421	.8255	.9089	.9921
59/64	.0768	.1601	.2435	.3268	.4101	.4935	.5768	.6601	.7434	.8268	.9102	.9934
15/16	.0781	.1614	.2448	.3281	.4114	.4948	.5781	.6614	.7447	.8281	.9114	.9947
61/64	.0794	.1628	.2461	.3294	.4127	.4961	.5794	.6627	.7460	.8294	.9127	.9960
31/32	.0807	.1641	.2474	.3307	.4140	.4974	.5807	.6640	.7473	.8307	.9140	.9973
63/64	.0820	.1654	.2487	.3320	.4153	.4987	.5820	.6653	.7487	.8320	.9153	.9986

FRACTIONS OF A LINEAL INCH IN DECIMALS

Fractions of an Inch	Decimal Equivalents	Fractions of an Inch	Decimal Equivalents
1/64	.015625	33/64	.515625
1/32	.03125	17/32	.53125
3/64	.04687	35/64	.546875
1/16	.0625	9/16	.5625
5/64	.078125	37/64	.578125
3/32	.09375	19/32	.59375
7/64	.109375	39/64	.609375
1/8	.125	5/8	.625
9/64	.140625	41/64	.640625
5/32	.15625	21/32	.65625
11/64	.171875	43/64	.671875
3/16	.1875	11/16	.6875
13/64	.203125	45/64	.703125
7/32	.21875	23/32	.71875
15/64	.234375	47/64	.734375
1/4	.25	3/4	.75
17/64	.265625	49/64	.765625
9/32	.28125	25/32	.78125
19/64	.296875	51/64	.796875
5/16	.3125	13/16	.8125
21/64	.328125	53/64	.828125
11/32	.34375	27/32	.84375
23/64	.359375	55/64	.859375
3/8	.375	7/8	.875
25/64	.390625	57/64	.890625
13/32	.40625	29/32	.90625
27/64	.421875	59/64	.921875
7/16	.4375	15/16	.9375
29/64	.453125	61/64	.953125
15/32	.46875	31/32	.96875
31/64	.484375	63/64	.984375
1/2	.5	1	1.000

EQUIVALENTS OF MEASURE

LENGTHS

1 meter, m = 10 decimeters, dm = 100 centimeters, cm = 1000 millimeters, mm.
1 meter, m = 0.1 decameter, dkm = 0.01 hectometer, hm = 0.001 kilometer, km.
1 meter, m = 39.37 inches, U. S. Standard = 39.370113 inches, British Standard.
1 millimeter, mm = 1000 microns, μ = 0.03937 inch = 39.37 mils.

Meters, m	Inches, in.	Feet, ft.	Yard, yd.	Rods, r.	Chains, ch.	Miles, U. S.		Kilometers, km.
						Statute	Nautical	
1	39.37	3.28083	1.09361	0.19884	0.04971	$0.^{3}_{0}6214$	$0.^{3}_{0}5396$	0.001
0.02540	1	0.08333	0.02778	$0.^{2}_{0}5051$	$0.^{2}_{0}1263$	$0.^{4}_{0}1578$	$0.^{4}_{0}1371$	$0.^{4}_{0}2540$
0.30480	12	1	0.33333	0.06061	0.01515	$0.^{3}_{0}1894$	$0.^{3}_{0}1645$	$0.^{3}_{0}3048$
0.91440	36	3	1	0.18182	0.04545	$0.^{3}_{0}5682$	$0.^{3}_{0}4934$	$0.^{3}_{0}9144$
5.02921	198	16.5	5.5	1	0.25	$0.^{2}_{0}3125$	$0.^{2}_{0}2714$	$0.^{2}_{0}5029$
20.1168	792	66	22	4	1	0.01250	0.01085	0.02012
1609.35	63360	5280	1760	320	80	1	0.86839	1.60935
1853.25	72962.5	6080.20	2026.73	368.497	92.1243	1.15155	1	1.85325
1000	39370	3280.83	1093.61	198.838	49.7096	0.62137	0.53959	1

1 yard, U. S. = 1.0000029 yards British 1 yard British = 0.9999971 yard U. S.
1 chain, Gunter's = 100 links 1 link = 7.92 inches.
1 cable length, U. S. = 120 fathoms = 960 spans = 720 feet = 219.457 meters.
1 league, U. S. = 3 statute miles = 24 furlongs.
1 international geographical mile = 1/15° at equator = 7422 m
= 4.611808 U. S. statute miles.
1 international nautical mile = 1/60° at meridian = 1852 m
= 0.999326 U. S. nautical miles.
1 U. S. nautical mile = 1/60° of circumference of sphere whose surface equals that of the earth = 6080.27 feet = 1.15155 statute miles = 1853.27 meters.
1 British nautical mile = 6080.00 feet = 1.15152 statute miles = 1853.19 meters.

SURFACES AND AREAS

1 sq. meter, m^2 = 100 sq. decimeters, dm^2 = 10000 sq. centimeters, cm^2.
1 sq. meter, m^2 = 0.01 are, a = 0.0001 hectare, ha.
1 sq. millimeter, mm^2 = 0.01 cm^2 = 0.00155 sq. inch = 1973.5 circular mils.
1 are, a = 1 sq. decameter, dkm = 0.0247104 acre.

Sq. Meters, m^2	Sq. Inches, sq. in.	Sq. Feet, sq. ft.	Sq. Yards, sq. yd.	Sq. Rods, sq. r.	Acres, A	Hectares, ha.	Sq. Miles, Statute	Sq. Kilometers, km^2
1	1550.00	10.7639	1.19599	0.03954	$0.^{3}_{0}2471$	0.0001	$0.^{8}_{0}3861$	$0.^{5}_{0}1$
$0.^{3}_{0}6452$	1	$0.^{2}_{0}6944$	$0.^{3}_{0}7716$	$0.^{4}_{0}2551$	$0.^{6}_{0}1594$	$0.^{7}_{0}6452$	$0.^{7}_{0}2491$	$0.^{6}_{0}6452$
0.09290	144	1	0.11111	$0.^{2}_{0}3673$	$0.^{4}_{0}2296$	$0.^{5}_{0}9290$	$0.^{7}_{0}3587$	$0.^{5}_{0}9290$
0.83613	1296	9	1	0.03306	$0.^{3}_{0}2066$	$0.^{4}_{0}8361$	$0.^{6}_{0}3228$	$0.^{6}_{0}8361$
25.2930	39204	272.25	30.25	1	0.00625	$0.^{2}_{0}2529$	$0.^{5}_{0}9766$	$0.^{4}_{0}2529$
4046.87	6272640	43560	4840	160	1	0.40469	$0.^{2}_{0}1563$	$0.^{3}_{0}4047$
10000	15499969	107639	11959.9	395.366	2.47104	1	$0.^{2}_{0}3861$	0.01
2589999		27878400	3097600	102400	640	259.000	1	2.59000
1000000		10763867	1195985	39536.6	247.104	100	0.38610	1

1 sq. rod, sq. pole, or sq. perch = 625 sq. links = 1/160 acre.
1 sq. chain, Gunter's = 16 sq. rods = 1/10 acre.
1 acre = 4 sq. roods = 160 sq. rods. Square of 1 acre = 208.7103 feet square.

Notations $^{2}_{0}$, $^{3}_{0}$, $^{4}_{0}$, etc., indicate that the $^{2}_{0}$, $^{3}_{0}$, $^{4}_{0}$, etc., are to be replaced by 2, 3, 4, etc., ciphers.

EXAMPLE—1 sq. rod = $0.^{5}_{0}9766$ = 0.000009766 sq. miles.

EQUIVALENTS OF MEASURE

Volume and Capacity

1 cu. meter, m^3 = 1000 cu. decimeter, dm^3 = 1000000 cu. centimeters, cm^3.
1 liter, l = 10 deciliters, dl = 100 centiliters, cl = 1000 milliliters, ml = 1000 cu. centimeters, cm^3. or cc.
1 liter, l = 0.1 decaliter, dkl = 0.01 hectoliter, hl = 1 cu. decimeter, dm^3.

Cubic Decimeter, dm^3, l	Cubic Inches, cu. in.	Cubic Feet, cu. ft.	Cubic Yards, cu. yd.	U. S. Quarts		U. S. Gallons		U. S. Bushels, bu.
				Liquid, l. qt.	Dry, d. qt.	Liquid, l. gal.	Dry, d. gal.	
1	61.0234	0.03531	$0.^{2}_{0}1308$	1.05668	0.90808	0.26417	0.22702	0.02838
0.01639	1	$0.^{3}_{0}5787$	$0.^{4}_{0}2143$	0.01732	0.01488	$0.^{2}_{0}4329$	$0.^{2}_{0}3720$	$0.^{3}_{0}4650$
28.3170	1728	1	0.03704	29.9221	25.7140	7.48055	6.42851	0.80356
764.559	46656	27	1	807.896	694.279	201.974	173.570	21.6962
0.94636	57.75	0.03342	$0.^{2}_{0}1238$	1	0.85937	0.25	0.21484	0.02686
1.10123	67.2006	0.03889	$0.^{2}_{0}1440$	1.16365	1	0.29091	0.25	0.03125
3.78543	231	0.13368	$0.^{2}_{0}4951$	4	3.43747	1	0.85937	0.10742
4.40492	268.803	0.15556	$0.^{2}_{0}5761$	4.65460	4	1.16365	1	0.125
35.2393	2150.42	1.24446	0.04609	37.2368	32	9.30920	8	1

U. S. Dry Measure: 1 bushel = 4 pecks = 8 gallons = 32 quarts = 64 pints.
U. S. Liquid Measure: 1 gallon = 4 quarts = 8 pints = 32 gills = 128 fluid ounces.
U. S. Apoth. Measure: 1 fl. ounce, f℥ = 8 fl. drams, f℥ = 480 minims, $\mathcal{m}$ = 29.574 cu. cm^3.
British Imperial gallon dry and liquid measure = 1.03202 U. S. dry gal. = 1.20091 U. S. liquid gal.
British Imperial gallon = 277.410 cu. in. = 4545.9631 cm^3.
Weight of water at maximum density, 4°C, 45° Lat., and sea level.
1 cu. ft. = 62.4283 lbs. av. = 28.3170 kg 1 cu. in. = 0.57804 oz. av. = 16.3872 g.
1 gal., U. S. liquid = 8.34545 lbs. = 3.78543 kg.
1 gal., British Imperial = 10.0221 lbs. = 4.5459631 kg.

Masses and Weights

1 gram, g = 10 decigrams, dg = 100 centigrams, cg = 1000 milligrams, mg.
1 gram, g = 0.1 decagram, dkg = 0.01 hectogram, hg = 0.001 kilogram, kg.
1 kilogram, kg = 1 cu. decimeter of water or liter, 4°C, 45° Lat. and sea level = 15432.35639 grains, U. S. and British Standard.

Kilograms, kg.	Grains, gr.	Ounces		Pounds		Tons		
		Troy, oz. t.	Avoir, oz. av.	Troy, lb. t.	Avoir, lb. av.	Net, Short, 2000 lbs.	Gross, Long, 2240 lbs.	Metric, 1000 kg.
1	15432.4	32.1507	35.2740	2.67923	2.20462	$0.^{2}_{0}1102$	$0.^{3}_{0}9842$	0.001
$0.^{4}_{0}6480$	1	$0.^{3}_{0}2083$	$0.^{2}_{0}2286$	$0.^{3}_{0}1736$	$0.^{3}_{0}1429$	$0.^{7}_{0}7143$	$0.^{7}_{0}6378$	$0.^{7}_{0}6480$
0.03110	480	1	1.09714	0.08333	0.06857	$0.^{4}_{0}3429$	$0.^{4}_{0}3061$	$0.^{4}_{0}3110$
0.02835	437.5	0.91146	1	0.07595	0.06250	$0.^{4}_{0}3125$	$0.^{4}_{0}2790$	$0.^{4}_{0}2835$
0.37324	5760	12	13.1657	1	0.82286	$0.^{3}_{0}4114$	$0.^{3}_{0}3674$	$0.^{3}_{0}3732$
0.45359	7000	14.5833	16	1.21528	1	0.00050	$0.^{3}_{0}4464$	$0.^{3}_{0}4536$
907.185	14000000	29166.7	32000	2430.56	2000	1	0.89286	0.90719
1016.05	15680000	32666.7	35840	2722.22	2240	1.12	1	1.01605
1000	15432356	32150.7	35274.0	2679.23	2204.62	1.10231	0.98421	1

1 ounce avoir. = 16 drams, avoir. 1 ounce troy = 20 pennyweight, dwt.
1 ounce apoth., ℥ = 8 drams, 3 = 24 scruples, ℈ = 480 grains, gr = 31.1035 g.
1 hundredweight = 1/20 long ton = 4 quarters = 8 stone = 112 lbs. = 50.8024 kg.

Notations $\overset{2}{0}$, $\overset{3}{0}$, $\overset{4}{0}$, etc., indicate that the $\overset{2}{0}$, $\overset{3}{0}$, $\overset{4}{0}$, etc., are to be replaced by 2, 3, 4, etc., ciphers.

Example—1 grain = $0.^{2}_{0}2083$ = 0.002083 oz. t. 1 grain = $0.^{4}_{0}6480$ = 0.00006480 kg.

EQUIVALENTS OF MEASURE

Forces or Weights per Units of Length, Linear Weights

1 dyne per centimeter = 0.00101979 g/cm = 0.000183719 poundal/in.
1 gram per centimeter = 980.5966 dynes/cm = 0.180154 poundal/in.
1 poundal per inch = 5443.11 dynes/cm = 5.55081 g/cm = 0.0310832 pound/in.

Grams per Centimeter g/cm	Grains per Inch, gr./in.	Pounds per Inch, lb./in.	Pounds per Foot, lb./ft.	Pounds per Yard, lb./yd.	Kilograms per Meter, kg/m	Net Tons, 2000 lbs., per Mile	Gross Tons, 2240 lbs., per Mile	Metric Tons, 1000 kg, per Kilometer
1	39.1983	$0.^{2}_{0}5600$	0.06720	0.20159	0.10	0.17740	0.15839	0.10
0.02551	1	$0.^{3}_{0}1429$	$0.^{2}_{0}1714$	$0.^{2}_{0}5143$	$0.^{2}_{0}2551$	$0.^{2}_{0}4526$	$0.^{2}_{0}4041$	$0.^{2}_{0}2551$
178.579	7000	1	12	36	17.8579	31.6800	28.2857	17.8579
14.8816	583.333	0.08333	1	3	1.48816	2.64000	2.35714	1.48816
4.96054	194.444	0.02778	0.33333	1	0.49605	0.88000	0.78571	0.49605
10	391.983	0.05600	0.67197	2.01591	1	1.77400	1.58393	1
5.63698	220.960	0.03157	0.37879	1.13636	0.56370	1	0.89286	0.56370
6.31342	247.475	0.03535	0.42424	1.27273	0.63134	1.12	1	0.63134
10	391.983	0.05600	0.67197	2.01591	1	1.77400	1.58393	1

Forces or Weights per Units of Area, Pressure

1 dyne per sq. centimeter = 0.00101979 g/cm² = 0.000466646 poundals/in².
1 gram per sq. centimeter = 980.5966 dynes/cm² = 0.457592 poundals/in².
1 poundal per sq. inch = 2142.95 dynes/cm² = 2.18536 g/cm² = 0.0310832 pound/in².

Kilograms per Sq. Centimeter, kg/cm²	Pounds per Sq. Inch, lb./in.²	Pounds per Sq. Foot, lb./ft.²	Net Tons, 2000 lbs. per Sq. Foot	Atmospheres, Standard, 760 mm	Columns of Mercury, Hg. 13.59593 Sp. G.		Columns of Water, Max. Density 4° C	
					Millimeters	Inches	Meters	Feet
1	14.2234	2048.17	1.02408	0.96778	735.514	28.9572	10	32.8083
0.07031	1	144	0.07200	0.06804	51.7116	2.03588	0.70307	2.30665
$0.^{3}_{0}4882$	$0.^{2}_{0}6944$	1	0.00050	$0.^{3}_{0}4725$	0.35911	0.01414	$0.^{2}_{0}4882$	0.01602
0.97648	13.8889	2000	1	0.94502	718.216	28.2762	9.76482	32.0367
1.03329	14.6969	2116.35	1.05818	1	760	29.9212	10.3329	33.9006
$0.^{2}_{0}1360$	0.01934	2.78468	$1.^{2}_{0}1392$	$0.^{2}_{0}1316$	1	0.03937	0.01360	0.04461
0.03453	0.49119	70.7310	0.03537	0.03342	25.4001	1	0.34534	1.13299
0.10	1.42234	204.817	0.10241	0.09678	73.5514	2.89572	1	3.28083
0.03048	0.43353	62.4283	0.03121	0.02950	22.4185	0.88262	0.30480	1

Forces or Weights per Units of Volume, Density

1 dyne per cu. centimeter = 0.00101979 gram/cm³ = 0.00118528 poundals/in³.
1 gram per cu. centimeter = 980.5966 dynes/cm³ = 1.162283 poundals/in³.
1 poundal per cu. inch = 843.683 dynes/cm³ = 0.860378 g/cm³ = 0.0310832 pound/in³.

Grams per Cu. Centimeter, g/cm³	Pounds per Cu. Inch, lb./in.³	Pounds per Cu. Foot, lb./ft.³	Pounds per Cu. Yard, lb./yd.³	Kilograms per Cu. Meter, kg/m³	Pounds per Bushel, U. S.	Pounds per Gallon, Dry, U. S.	Pounds per Gallon, Liquid, U. S.	Kilograms per Hectoliter, kg/hl
1	0.03613	62.4283	1685.56	1000	77.6893	9.71116	8.34545	100
27.6797	1	1728	46656	27679.7	2150.42	268.803	231	2767.97
0.01602	$0.^{3}_{0}5787$	1	27	16.0184	1.24446	0.15556	0.13368	1.60184
$0.^{3}_{0}5933$	$0.^{1}_{0}2143$	0.03704	1	0.59327	0.04609	$0.^{2}_{0}5762$	$0.^{2}_{0}4951$	0.05933
0.001	$0.^{4}_{0}3613$	0.06243	1.68556	1	0.07769	$0.^{2}_{0}9711$	$0.^{2}_{0}8345$	0.10
0.01287	$0.^{3}_{0}4650$	0.80356	21.6962	12.8718	1	0.125	0.10742	1.28718
0.10297	$0.^{2}_{0}3720$	6.42851	173.570	102.974	8	1	0.85937	10.2974
0.11983	$0.^{2}_{0}4329$	7.48052	201.974	119.826	9.30920	1.16365	1	11.9826
0.01	$0.^{3}_{0}3613$	0.62428	16.8557	10	0.77689	0.09711	0.08345	1

Notations $^{2}_{0}$, $^{3}_{0}$, $^{4}_{0}$, etc., indicate that the $^{2}_{0}$, $^{3}_{0}$, $^{4}_{0}$, etc., are to be replaced by 2, 3, 4, etc. ciphers. Example—1 kg/m³ = $0.^{4}_{0}3613$ = 0.00003613 lb./in³.

EQUIVALENTS OF MEASURE

Energy, Work, Heat

1 dyne-centimeter=1 erg=0.00101979 gram-centimeter=$0.^{7}737612$ foot-pc
1 gram-centimeter=980.5966 ergs=$0.^{4}7233$ foot-pound.
1 foot-pound=13557300 ergs=13825.5 gram-centimeters.

Kilogram-meters, kg-m	Foot-Pounds, ft.-lbs.	Horsepower-hour		Poncelet-hours, 100 kg-m-h	Kilowatt-hours, kw-h	Joules, 10^7 ergs j-s		
		U. S., H. P.-h	Metric, 75 kg-m-h					
1	7.23300	$0.^{5}3653$	$0.^{5}3704$	$0.^{5}2778$	$0.^{5}2724$	9.8050		
0.13826	1	$0.^{5}5051$	$0.^{5}5121$	$0.^{6}3840$	$0.^{6}3766$	1.35573	C	
273745	1980000	1	1.01387	0.76040	0.74565	2684340	2(	
270000	1952910	0.98632	1	0.75	0.73545	2647610	25	
360000	2603880	1.31509	1.33333	1	0.98060	3530147	33	
367123	2655403	1.34111	1.35972	1.01979	1	3600000	341	
0.10198	0.73761	$0.^{6}3725$	$0.^{6}3777$	$0.^{6}2833$	$0.^{6}2778$	1	$0.^{3}9480$	
107.577	778.104	$0.^{3}3930$	$0.^{3}3984$	$0.^{3}2988$	$0.^{3}2930$	1054.90	1	0.25200
426.900	3087.77	$0.^{2}1559$	$0.^{2}1581$	$0.^{2}1186$	$0.^{2}1163$	4186.17	3.96832	1

Power, Rate of Energy and Heat

1 erg per sec.=1 dyne-cm/sec.=0.00101979 gram-cm/sec.=$0.^{7}737612$ foot-pounds/sec.
1 gram-centimeter per second=980.5966 ergs/sec.=$0.^{4}7238$ foot-pounds/sec.
1 foot-pound per second=13557300 ergs/sec=13825.5 gram-cm/sec.

Kilogram-meters per Second, kg-m/s	Foot-pounds per Second, ft.-lbs./s	Horsepower		Poncelet, 100 kg-m/s	Kilowatt, kw.	Watts, 10^7 ergs/s	Thermal Units per Sec.	
		U. S., 550 ft.-lbs./s	Metric, 75 kg-m/s				B. T. U. btu/s	Calorie kg-cal/s
1	7.23300	0.01315	0.01333	0.01	$0.^{2}9806$	9.80597	$0.^{2}9296$	$0.^{2}2342$
0.13826	1	$0.^{2}1818$	$0.^{2}1843$	$0.^{3}1383$	$0.^{2}1356$	1.35573	$0.^{2}1285$	$0.^{3}3237$
76.0404	550	1	1.01387	0.76040	0.74565	745.650	0.70685	0.17812
75	542.475	0.98632	1	0.75	0.73545	735.448	0.69718	0.17569
100	723.300	1.31509	1.33333	1	0.98060	980.597	0.92957	0.23425
101.979	737.612	1.34111	1.35972	1.01979	1	1000	0.94796	0.23888
0.10198	0.73761	$0.^{2}1341$	$0.^{2}1360$	$0.^{3}1020$	0.001	1	$0.^{3}9480$	$0.^{3}2389$
107.577	778.104	1.41474	1.43436	1.07577	1.05490	1054.90	1	0.25200
426.900	3087.77	5.61412	5.69200	4.26900	4.18617	4186.17	3.96832	1

Velocities and Accelerations

1 kine=1 centimeter per second=0.0328083 foot per second.
1 radian per second=57.2958 degrees per sec.=0.159155 revolutions per sec.
1 gravity=980.5966 centimeters per sec. per sec.=32.1717 feet per sec. per sec.

Meters per Second, m/s	Feet per Second, ft./s	Miles per Hour, M/h	Knots per Hour, U. S.	Kilometers Hour, km/h	Meter per sec/sec m/s^2	Feet per sec/sec $ft./s^2$	Miles per hour/sec M/h-s	Kilometer per hour/sec km/h-s
1	3.28083	2.23693	1.94254	3.6				
0.30480	1	0.68182	0.59209	1.09728				
0.44704	1.46667	1	0.86839	1.60935				
0.51479	1.68894	1.15155	1	1.85325				
0.27778	0.91134	0.62137	0.53959	1				
					1	3.28083	2.23693	3.6
					0.30480	1	0.68182	1.09728
					0.44704	1.46667	1	1.60935
					0.27778	0.91134	0.62137	1

Notations $^{2}0$, $^{3}0$, $^{4}0$, etc., indicate that the $^{2}0$, $^{3}0$, $^{4}0$, etc., are to be replaced by 2, 3, 4, etc., ciphers. Example—1 Calorie=$0.^{2}1163$=0.001163 kilowatt-hours.

METRIC CONVERSION TABLES

INCHES TO CENTIMETERS—1 in.=2.540005 cm

Units / Tens	0	1	2	3	4	5	6	7	8	9
0		2.540	5.080	7.620	10.160	12.700	15.240	17.780	20.320	22.860
1	25.400	27.940	30.480	33.020	35.560	38.100	40.640	43.180	45.720	48.260
2	50.800	53.340	55.880	58.420	60.960	63.500	66.040	68.580	71.120	73.660
3	76.200	78.740	81.280	83.820	86.360	88.900	91.440	93.980	96.520	99.060
4	101.600	104.140	106.680	109.220	111.760	114.300	116.840	119.380	121.920	124.460
5	127.000	129.540	132.080	134.620	137.160	139.700	142.240	144.780	147.320	149.860
6	152.400	154.940	157.480	160.020	162.560	165.100	167.640	170.180	172.720	175.260
7	177.800	180.340	182.880	185.420	187.960	190.500	193.040	195.580	198.120	200.660
8	203.200	205.740	208.280	210.820	213.360	215.900	218.440	220.980	223.520	226.060
9	228.600	231.140	233.680	236.220	238.760	241.300	243.840	246.380	248.920	251.460

INCHES^2 TO CENTIMETERS^2—1 in.^{2}=6.451625 cm^2

Units / Tens	0	1	2	3	4	5	6	7	8	9
0		6.452	12.903	19.355	25.807	32.258	38.710	45.161	51.613	58.065
1	64.516	70.968	77.420	83.871	90.323	96.774	103.226	109.678	116.129	122.581
2	129.033	135.484	141.936	148.387	154.839	161.291	167.742	174.194	180.646	187.097
3	193.549	200.000	206.452	212.904	219.355	225.807	232.259	238.710	245.162	251.613
4	258.065	264.517	270.968	277.420	283.872	290.323	296.775	303.226	309.678	316.130
5	322.581	329.033	335.485	341.936	348.388	354.839	361.291	367.743	374.194	380.646
6	387.098	393.549	400.001	406.452	412.904	419.356	425.807	432.259	438.711	445.162
7	451.614	458.065	464.517	470.969	477.420	483.872	490.324	496.775	503.227	509.678
8	516.130	522.582	529.033	535.485	541.937	548.388	554.840	561.291	567.743	574.195
9	580.646	587.098	593.550	600.001	606.453	612.904	619.356	625.808	632.259	638.711

INCHES^3 TO CENTIMETERS^3—1 in.^{3}=16.38716 cm^3

Units / Tens	0	1	2	3	4	5	6	7	8	9
0		16.39	32.77	49.16	65.55	81.94	98.32	114.71	131.10	147.48
1	163.87	180.26	196.65	213.03	229.42	245.81	262.19	278.58	294.97	311.36
2	327.74	344.13	360.52	376.90	393.29	409.68	426.07	442.45	458.84	475.23
3	491.61	508.00	524.39	540.78	557.16	573.55	589.94	606.32	622.71	639.10
4	655.49	671.87	688.26	704.65	721.04	737.42	753.81	770.20	786.58	802.97
5	819.36	835.75	852.13	868.52	884.91	901.29	917.68	934.07	950.46	966.84
6	983.23	999.62	1016.00	1032.39	1048.78	1065.17	1081.55	1097.94	1114.33	1130.71
7	1147.10	1163.49	1179.88	1196.26	1212.65	1229.04	1245.42	1261.81	1278.20	1294.59
8	1310.97	1327.36	1343.75	1360.13	1376.52	1392.91	1409.30	1425.68	1442.07	1458.46
9	1474.84	1491.23	1507.62	1524.01	1540.39	1556.78	1573.17	1589.55	1605.94	1622.33

INCHES^4 TO CENTIMETERS^4—1 in.^{4}=41.62347 cm^4

Units / Tens	0	1	2	3	4	5	6	7	8	9
0		41.62	83.25	124.87	166.49	208.12	249.74	291.36	332.99	374.61
1	416.23	457.86	499.48	541.11	582.73	624.35	665.98	707.60	749.22	790.85
2	832.47	874.09	915.72	957.34	998.96	1040.59	1082.21	1123.83	1165.46	1207.08
3	1248.70	1290.33	1331.95	1373.57	1415.20	1456.82	1498.44	1540.07	1581.69	1623.32
4	1664.94	1706.56	1748.19	1789.81	1831.43	1873.06	1914.68	1956.30	1997.93	2039.55
5	2081.17	2122.80	2164.42	2206.04	2247.67	2289.29	2330.91	2372.54	2414.16	2455.78
6	2497.41	2539.03	2580.66	2622.28	2663.90	2705.53	2747.15	2788.77	2830.40	2872.02
7	2913.64	2955.27	2996.89	3038.51	3080.14	3121.76	3163.38	3205.01	3246.63	3288.25
8	3329.88	3371.50	3413.12	3454.75	3496.37	3537.99	3579.62	3621.24	3662.87	3704.49
9	3746.11	3787.74	3829.36	3870.98	3912.61	3954.23	3995.85	4037.48	4079.10	4120.72

METRIC CONVERSION TABLES

CENTIMETERS TO INCHES—1 cm=0.3937 in.

Tens \ Units	0	1	2	3	4	5	6	7	8	9
0		0.3937	0.7874	1.1811	1.5748	1.9685	2.3622	2.7559	3.1496	3.5433
1	3.9370	4.3307	4.7244	5.1181	5.5118	5.9055	6.2992	6.6929	7.0866	7.4803
2	7.8740	8.2677	8.6614	9.0551	9.4488	9.8425	10.2362	10.6299	11.0236	11.4173
3	11.8110	12.2047	12.5984	12.9921	13.3858	13.7795	14.1732	14.5669	14.9606	15.3543
4	15.7480	16.1417	16.5354	16.9291	17.3228	17.7165	18.1102	18.5039	18.8976	19.2913
5	19.6850	20.0787	20.4724	20.8661	21.2598	21.6535	22.0472	22.4409	22.8346	23.2283
6	23.6220	24.0157	24.4094	24.8031	25.1968	25.5905	25.9842	26.3779	26.7716	27.1653
7	27.5590	27.9527	28.3464	28.7401	29.1338	29.5275	29.9212	30.3149	30.7086	31.1023
8	31.4960	31.8897	32.2834	32.6771	33.0708	33.4645	33.8582	34.2519	34.6456	35.0393
9	35.4330	35.8267	36.2204	36.6141	37.0078	37.4015	37.7952	38.1889	38.5826	38.9763

CENTIMETERS^2 TO INCHES^2—1 cm^2=0.15499969 in.^{2}.

Tens \ Units	0	1	2	3	4	5	6	7	8	9
0		0.1550	0.3100	0.4650	0.6200	0.7750	0.9300	1.0850	1.2400	1.3950
1	1.5500	1.7050	1.8600	2.0150	2.1700	2.3250	2.4800	2.6350	2.7900	2.9450
2	3.1000	3.2550	3.4100	3.5650	3.7200	3.8750	4.0300	4.1850	4.3400	4.4950
3	4.6500	4.8050	4.9600	5.1150	5.2700	5.4250	5.5800	5.7350	5.8900	6.0450
4	6.2000	6.3550	6.5100	6.6650	6.8200	6.9750	7.1300	7.2850	7.4400	7.5950
5	7.7500	7.9050	8.0600	8.2150	8.3700	8.5250	8.6800	8.8350	8.9900	9.1450
6	9.3000	9.4550	9.6100	9.7650	9.9200	10.0750	10.2300	10.3850	10.5400	10.6950
7	10.8500	11.0050	11.1600	11.3150	11.4700	11.6250	11.7800	11.9350	12.0900	12.2450
8	12.4000	12.5550	12.7100	12.8650	13.0200	13.1750	13.3300	13.4850	13.6400	13.7950
9	13.9500	14.1050	14.2600	14.4150	14.5700	14.7250	14.8800	15.0350	15.1900	15.3450

CENTIMETERS^3 TO INCHES^3—1 cm^3=0.0610234 in.^{3}.

Tens \ Units	0	1	2	3	4	5	6	7	8	9
0		0.06102	0.12205	0.18307	0.24409	0.30512	0.36614	0.42716	0.48819	0.54921
1	0.61023	0.67126	0.73228	0.79330	0.85433	0.91535	0.97637	1.03740	1.09842	1.15944
2	1.22047	1.28149	1.34251	1.40354	1.46456	1.52559	1.58661	1.64763	1.70866	1.76968
3	1.83070	1.89173	1.95275	2.01377	2.07480	2.13582	2.19684	2.25787	2.31889	2.37991
4	2.44094	2.50196	2.56298	2.62401	2.68503	2.74605	2.80708	2.86810	2.92912	2.99015
5	3.05117	3.11219	3.17322	3.23424	3.29526	3.35629	3.41731	3.47833	3.53936	3.60038
6	3.66140	3.72243	3.78345	3.84447	3.90550	3.96652	4.02754	4.08857	4.14959	4.21061
7	4.27164	4.33266	4.39368	4.45471	4.51573	4.57675	4.63778	4.69880	4.75983	4.82085
8	4.88187	4.94290	5.00392	5.06494	5.12597	5.18699	5.24801	5.30904	5.37006	5.43108
9	5.49211	5.55313	5.61415	5.67518	5.73620	5.79722	5.85825	5.91927	5.98029	6.04132

CENTIMETERS^4 TO INCHES^4—1 cm^4=0.0240249 in.^{4}.

Tens \ Units	0	1	2	3	4	5	6	7	8	9
0		0.02402	0.04805	0.07207	0.09610	0.12012	0.14415	0.16817	0.19220	0.21622
1	0.24025	0.26427	0.28830	0.31232	0.33635	0.36037	0.38440	0.40842	0.43245	0.45647
2	0.48050	0.50452	0.52855	0.55257	0.57660	0.60062	0.62465	0.64867	0.67270	0.69672
3	0.72075	0.74477	0.76880	0.79282	0.81685	0.84087	0.86490	0.88892	0.91295	0.93697
4	0.96100	0.98502	1.00905	1.03307	1.05710	1.08112	1.10515	1.12917	1.15320	1.17722
5	1.20125	1.22527	1.24930	1.27332	1.29734	1.32137	1.34539	1.36942	1.39344	1.41747
6	1.44149	1.46552	1.48954	1.51357	1.53759	1.56162	1.58564	1.60967	1.63369	1.65772
7	1.68174	1.70577	1.72979	1.75382	1.77784	1.80187	1.82589	1.84992	1.87394	1.89797
8	1.92199	1.94602	1.97004	1.99407	2.01809	2.04212	2.06614	2.09017	2.11419	2.13822
9	2.16224	2.18627	2.21029	2.23432	2.25834	2.28237	2.30639	2.33042	2.35444	2.37847

METRIC CONVERSION TABLES

FEET TO METERS—1 ft.=0.3048006 m

Units / Tens	0	1	2	3	4	5	6	7	8	9
0		0.3048	0.6096	0.9144	1.2192	1.5240	1.8288	2.1336	2.4384	2.7432
1	3.0480	3.3528	3.6576	3.9624	4.2672	4.5720	4.8768	5.1816	5.4864	5.7912
2	6.0960	6.4008	6.7056	7.0104	7.3152	7.6200	7.9248	8.2296	8.5344	8.8392
3	9.1440	9.4488	9.7536	10.0584	10.3632	10.6680	10.9728	11.2776	11.5824	11.8872
4	12.1920	12.4968	12.8016	13.1064	13.4112	13.7160	14.0208	14.3256	14.6304	14.9352
5	15.2400	15.5448	15.8496	16.1544	16.4592	16.7640	17.0688	17.3736	17.6784	17.9832
6	18.2880	18.5928	18.8976	19.2024	19.5072	19.8120	20.1168	20.4216	20.7264	21.0312
7	21.3360	21.6408	21.9456	22.2504	22.5552	22.8600	23.1648	23.4696	23.7744	24.0792
8	24.3840	24.6888	24.9936	25.2984	25.6033	25.9081	26.2129	26.5177	26.8225	27.1273
9	27.4321	27.7369	28.0417	28.3465	28.6513	28.9561	29.2609	29.5657	29.8705	30.1753

POUNDS PER FOOT TO KILOGRAMS PER METER—1 lb./ft.=1.488161 kg/m

Units / Tens	0	1	2	3	4	5	6	7	8	9
0		1.488	2.976	4.464	5.953	7.441	8.929	10.417	11.905	13.393
1	14.882	16.370	17.858	19.346	20.834	22.322	23.811	25.299	26.787	28.275
2	29.763	31.251	32.740	34.228	35.716	37.204	38.692	40.180	41.669	43.157
3	44.645	46.133	47.621	49.109	50.597	52.086	53.574	55.062	56.550	58.038
4	59.526	61.015	62.503	63.991	65.479	66.967	68.455	69.944	71.432	72.920
5	74.408	75.896	77.384	78.873	80.361	81.849	83.337	84.825	86.313	87.802
6	89.290	90.778	92.266	93.754	95.242	96.730	98.219	99.707	101.195	102.683
7	104.171	105.659	107.148	108.636	110.124	111.612	113.100	114.588	116.077	117.565
8	119.053	120.541	122.029	123.517	125.006	126.494	127.982	129.470	130.958	132.446
9	133.934	135.423	136.911	138.399	139.887	141.375	142.863	144.352	145.840	147.328

POUNDS PER SQ. INCH TO KG. PER SQ. CM.—1 lb./in.^{2}=0.0703067 kg/cm^2

Units / Tens	0	1	2	3	4	5	6	7	8	9
0		0.07031	0.14061	0.21092	0.28123	0.35153	0.42184	0.49215	0.56245	0.63276
1	0.70307	0.77337	0.84368	0.91399	0.98429	1.05460	1.12491	1.19521	1.26552	1.33583
2	1.40613	1.47644	1.54675	1.61705	1.68736	1.75767	1.82797	1.89828	1.96859	2.03889
3	2.10920	2.17951	2.24981	2.32012	2.39043	2.46073	2.53104	2.60135	2.67165	2.74196
4	2.81227	2.88257	2.95288	3.02319	3.09349	3.16380	3.23411	3.30441	3.37472	3.44503
5	3.51534	3.58564	3.65595	3.72626	3.79656	3.86687	3.93718	4.00748	4.07779	4.14810
6	4.21840	4.28871	4.35902	4.42932	4.49963	4.56994	4.64024	4.71055	4.78086	4.85116
7	4.92147	4.99178	5.06208	5.13239	5.20270	5.27300	5.34331	5.41362	5.48392	5.55423
8	5.62454	5.69484	5.76515	5.83546	5.90576	5.97607	6.04638	6.11668	6.18699	6.25730
9	6.32760	6.39791	6.46822	6.53852	6.60883	6.67914	6.74944	6.81975	6.89006	6.96036

INCH-POUNDS TO KILOGRAM-CENTIMETERS—1 in-lb.=1.152127 kg-cm

Units / Tens	0	1	2	3	4	5	6	7	8	9
0		1.152	2.304	3.456	4.609	5.761	6.913	8.065	9.217	10.369
1	11.521	12.673	13.826	14.978	16.130	17.282	18.434	19.586	20.738	21.890
2	23.043	24.195	25.347	26.499	27.651	28.803	29.955	31.107	32.260	33.412
3	34.564	35.716	36.868	38.020	39.172	40.324	41.477	42.629	43.781	44.933
4	46.085	47.237	48.389	49.541	50.694	51.846	52.998	54.150	55.302	56.454
5	57.606	58.758	59.911	61.063	62.215	63.367	64.519	65.671	66.823	67.975
6	69.128	70.280	71.432	72.584	73.736	74.888	76.040	77.193	78.345	79.497
7	80.649	81.801	82.953	84.105	85.257	86.410	87.562	88.714	89.866	91.018
8	92.170	93.322	94.474	95.627	96.779	97.931	99.083	100.235	101.387	102.539
9	103.691	104.844	105.996	107.148	108.300	109.452	110.604	111.756	112.908	114.061

METRIC CONVERSION TABLES

Meters to Feet—1 m=3.2808333 ft.

Tens \ Units	0	1	2	3	4	5	6	7	8	9
0	. .	3.281	6.562	9.843	13.123	16.404	19.685	22.966	26.247	29.528
1	32.808	36.089	39.370	42.651	45.932	49.213	52.493	55.774	59.055	62.336
2	65.617	68.898	72.178	75.459	78.740	82.021	85.302	88.583	91.863	95.144
3	98.425	101.706	104.987	108.268	111.548	114.829	118.110	121.391	124.672	127.953
4	131.233	134.514	137.795	141.076	144.357	147.638	150.918	154.199	157.480	160.761
5	164.042	167.323	170.603	173.884	177.165	180.446	183.727	187.008	190.288	193.569
6	196.850	200.131	203.412	206.693	209.973	213.254	216.535	219.816	223.097	226.378
7	229.658	232.939	236.220	239.501	242.782	246.063	249.343	252.624	255.905	259.186
8	262.467	265.748	269.028	272.309	275.590	278.871	282.152	285.433	288.713	291.994
9	295.275	298.556	301.837	305.118	308.398	311.679	314.960	318.241	321.522	324.803

Kilograms Per Meter to Pounds Per Foot—1 kg/m=0.67197 lb./ft.

Tens \ Units	0	1	2	3	4	5	6	7	8	9
0		0.6720	1.3439	2.0159	2.6879	3.3599	4.0318	4.7038	5.3758	6.0477
1	6.7197	7.3917	8.0636	8.7356	9.4076	10.0796	10.7515	11.4235	12.0955	12.7674
2	13.4394	14.1114	14.7833	15.4553	16.1273	16.7993	17.4712	18.1432	18.8152	19.4871
3	20.1591	20.8311	21.5030	22.1750	22.8470	23.5190	24.1909	24.8629	25.5349	26.2068
4	26.8788	27.5508	28.2227	28.8947	29.5667	30.2387	30.9106	31.5826	32.2546	32.9265
5	33.5985	34.2705	34.9424	35.6144	36.2864	36.9584	37.6303	38.3022	38.9743	39.6462
6	40.3182	40.9902	41.6621	42.3341	43.0061	43.6781	44.3500	45.0220	45.6940	46.3659
7	47.0379	47.7099	48.3818	49.0538	49.7258	50.3978	51.0697	51.7417	52.4137	53.0856
8	53.7576	54.4296	55.1015	55.7735	56.4455	57.1175	57.7894	58.4614	59.1334	59.8053
9	60.4773	61.1493	61.8212	62.4932	63.1652	63.8372	64.5091	65.1811	65.8531	66.5250

Kg. per Sq. Cm. to Pounds per Sq. Inch—1 kg/cm^2=14.2234 lbs./in.^{2}

Tens \ Units	0	1	2	3	4	5	6	7	8	9
0		14.22	28.45	42.67	56.89	71.12	85.34	99.56	113.79	128.01
1	142.23	156.46	170.68	184.90	199.13	213.35	227.57	241.80	256.02	270.24
2	284.47	298.69	312.91	327.14	341.36	355.59	369.81	384.03	398.26	412.48
3	426.70	440.93	455.15	469.37	483.60	497.82	512.04	526.27	540.49	554.71
4	568.94	583.16	597.38	611.61	625.83	640.05	654.28	668.50	682.72	696.95
5	711.17	725.39	739.62	753.84	768.06	782.29	796.51	810.73	824.96	839.18
6	853.40	867.63	881.85	896.07	910.30	924.52	938.74	952.97	967.19	981.41
7	995.64	1009.86	1024.08	1038.31	1052.53	1066.76	1080.98	1095.20	1109.43	1123.65
8	1137.87	1152.10	1166.32	1180.54	1194.77	1208.99	1223.21	1237.44	1251.66	1265.88
9	1280.11	1294.33	1308.55	1322.78	1337.00	1351.22	1365.45	1379.67	1393.89	1408.12

Kilogram-Centimeters to Inch-Pounds—1 kg/cm=0.86796 in./lb.

Tens \ Units	0	1	2	3	4	5	6	7	8	9
0		0.8680	1.7359	2.6039	3.4718	4.3398	5.2078	6.0757	6.9437	7.8116
1	8.6796	9.5476	10.4155	11.2835	12.1514	13.0194	13.8874	14.7553	15.6233	16.4912
2	17.3592	18.2272	19.0951	19.9631	20.8310	21.6990	22.5670	23.4349	24.3029	25.1708
3	26.0388	26.9068	27.7747	28.6427	29.5106	30.3786	31.2466	32.1145	32.9825	33.8504
4	34.7184	35.5864	36.4543	37.3223	38.1902	39.0582	39.9262	40.7941	41.6621	42.5300
5	43.3980	44.2660	45.1339	46.0019	46.8698	47.7378	48.6058	49.4737	50.3417	51.2096
6	52.0776	52.9456	53.8135	54.6815	55.5494	56.4174	57.2854	58.1533	59.0213	59.8892
7	60.7572	61.6252	62.4931	63.3611	64.2290	65.0970	65.9650	66.8329	67.7009	68.5688
8	69.4368	70.3048	71.1727	72.0407	72.9086	73.7766	74.6446	75.5125	76.3805	77.2484
9	78.1164	78.9844	79.8523	80.7203	81.5882	82.4562	83.3242	84.1921	85.0601	85.9280

METRIC CONVERSION TABLE

Inches to Millimeters

39.37 inches, U. S. Standard=1 meter=100 centimeters=1000 millimeters.

Inches	0	1/16	1/8	3/16	1/4	5/16	3/8	7/16
0	0.00	1.59	3.18	4.76	6.35	7.94	9.53	11.11
1	25.40	26.99	28.58	30.16	31.75	33.34	34.93	36.51
2	50.80	52.39	53.98	55.56	57.15	58.74	60.33	61.91
3	76.20	77.79	79.38	80.96	82.55	84.14	85.73	87.31
4	101.60	103.19	104.78	106.36	107.95	109.54	111.13	112.71
5	127.00	128.59	130.18	131.76	133.35	134.94	136.53	138.11
6	152.40	153.99	155.58	157.16	158.75	160.34	161.93	163.51
7	177.80	179.39	180.98	182.56	184.15	185.74	187.33	188.91
8	203.20	204.79	206.38	207.96	209.55	211.14	212.73	214.31
9	228.60	230.19	231.78	233.36	234.95	236.54	238.13	239.71
10	254.00	255.59	257.18	258.76	260.35	261.94	263.53	265.11
11	279.40	280.99	282.58	284.16	285.75	287.34	288.93	290.51
12	304.80	306.39	307.98	309.56	311.15	312.74	314.33	315.91
13	330.20	331.79	333.38	334.96	336.55	338.14	339.73	341.31
14	355.60	357.19	358.78	360.36	361.95	363.54	365.13	366.71
15	381.00	382.59	384.18	385.76	387.35	388.94	390.53	392.11
16	406.40	407.99	409.58	411.16	412.75	414.34	415.93	417.51
17	431.80	433.39	434.98	436.56	438.15	439.74	441.33	442.91
18	457.20	458.79	460.38	461.96	463.55	465.14	466.73	468.31
19	482.60	484.19	485.78	487.36	488.95	490.54	492.13	493.71
20	508.00	509.59	511.18	512.76	514.35	515.94	517.53	519.11
21	533.40	534.99	536.58	538.16	539.75	541.34	542.93	544.51
22	558.80	560.39	561.98	563.56	565.15	566.74	568.33	569.91
23	584.20	585.79	587.38	588.96	590.55	592.14	593.73	595.31
24	609.60	611.19	612.78	614.36	615.95	617.54	619.13	620.71
25	635.00	636.59	638.18	639.76	641.35	642.94	644.53	646.11
26	660.40	661.99	663.58	665.16	666.75	668.34	669.93	671.51
27	685.80	687.39	688.98	690.56	692.15	693.74	695.33	696.91
28	711.20	712.79	714.38	715.96	717.55	719.14	720.73	722.31
29	736.60	738.19	739.78	741.36	742.95	744.54	746.13	747.71
30	762.00	763.59	765.18	766.76	768.35	769.94	771.53	773.11
31	787.40	788.99	790.58	792.16	793.75	795.34	796.93	798.51
32	812.80	814.39	815.98	817.56	819.15	820.74	822.33	823.91
33	838.20	839.79	841.38	842.96	844.55	846.14	847.73	849.31
34	863.60	865.19	866.78	868.36	869.95	871.54	873.13	874.71
35	889.00	890.59	892.18	893.76	895.35	896.94	898.53	900.11
36	914.40	915.99	917.58	919.16	920.75	922.34	923.93	925.51
37	939.80	941.39	942.98	944.56	946.15	947.74	949.33	950.91
38	965.20	966.79	968.38	969.96	971.55	973.14	974.73	976.31
39	990.60	992.19	993.78	995.36	996.95	998.54	1000.13	1001.71
40	1016.00	1017.59	1019.18	1020.76	1022.35	1023.94	1025.53	1027.11
41	1041.40	1042.99	1044.58	1046.16	1047.75	1049.34	1050.93	1052.51
42	1066.80	1068.39	1069.98	1071.56	1073.15	1074.74	1076.33	1077.91
43	1092.20	1093.79	1095.38	1096.96	1098.55	1100.14	1101.73	1103.31
44	1117.60	1119.19	1120.78	1122.36	1123.95	1125.54	1127.13	1128.71
45	1143.00	1144.59	1146.18	1147.76	1149.35	1150.94	1152.53	1154.11
46	1168.40	1169.99	1171.58	1173.16	1174.75	1176.34	1177.93	1179.51
47	1193.80	1195.39	1196.98	1198.56	1200.15	1201.74	1203.33	1204.91
48	1219.20	1220.79	1222.38	1223.96	1225.55	1227.14	1228.73	1230.31
49	1244.60	1246.19	1247.78	1249.36	1250.95	1252.54	1254.13	1255.71
50	1270.00	1271.59	1273.18	1274.76	1276.35	1277.94	1279.53	1281.11

METRIC CONVERSION TABLE

Inches to Millimeters

39.37 inches, U. S. Standard=1 meter=100 centimeters=1000 millimeters

Inches	½	9/16	5/8	11/16	¾	13/16	7/8	15/16
0	12.70	14.29	15.88	17.46	19.05	20.64	22.23	23.81
1	38.10	39.69	41.28	42.86	44.45	46.04	47.63	49.21
2	63.50	65.09	66.68	68.26	69.85	71.44	73.03	74.61
3	88.90	90.49	92.08	93.66	95.25	96.84	98.43	100.01
4	114.30	115.89	117.48	119.06	120.65	122.24	123.83	125.41
5	139.70	141.29	142.88	144.46	146.05	147.64	149.23	150.81
6	165.10	166.69	168.28	169.86	171.45	173.04	174.63	176.21
7	190.50	192.09	193.68	195.26	196.85	198.44	200.03	201.61
8	215.90	217.49	219.08	220.66	222.25	223.84	225.43	227.01
9	241.30	242.89	244.48	246.06	247.65	249.24	250.83	252.41
10	266.70	268.29	269.88	271.46	273.05	274.64	276.23	277.81
11	292.10	293.69	295.28	296.86	298.45	300.04	301.63	303.21
12	317.50	319.09	320.68	322.26	323.85	325.44	327.03	328.61
13	342.90	344.49	346.08	347.66	349.25	350.84	352.43	354.01
14	368.30	369.89	371.48	373.06	374.65	376.24	377.83	379.41
15	393.70	395.29	396.88	398.46	400.05	401.64	403.23	404.81
16	419.10	420.69	422.28	423.86	425.45	427.04	428.63	430.21
17	444.50	446.09	447.68	449.26	450.85	452.44	454.03	455.61
18	469.90	471.49	473.08	474.66	476.25	477.84	479.43	481.01
19	495.30	496.89	498.48	500.06	501.65	503.24	504.83	506.41
20	520.70	522.29	523.88	525.46	527.05	528.64	530.23	531.81
21	546.10	547.69	549.28	550.86	552.45	554.04	555.63	557.21
22	571.50	573.09	574.68	576.26	577.85	579.44	581.03	582.61
23	596.90	598.49	600.08	601.66	603.25	604.84	606.43	608.01
24	622.30	623.89	625.48	627.06	628.65	630.24	631.83	633.41
25	647.70	649.29	650.88	652.46	654.05	655.64	657.23	658.81
26	673.10	674.69	676.28	677.86	679.45	681.04	682.63	684.21
27	698.50	700.09	701.68	703.26	704.85	706.44	708.03	709.61
28	723.90	725.49	727.08	728.66	730.25	731.84	733.43	735.01
29	749.30	750.89	752.48	754.06	755.65	757.24	758.83	760.41
30	774.70	776.29	777.88	779.46	781.05	782.64	784.23	785.81
31	800.10	801.69	803.28	804.86	806.45	808.04	809.63	811.21
32	825.50	827.09	828.68	830.26	831.85	833.44	835.03	836.61
33	850.90	852.49	854.08	855.66	857.25	858.84	860.43	862.01
34	876.30	877.89	879.48	881.06	882.65	884.24	885.83	887.41
35	901.70	903.29	904.88	906.46	908.05	909.64	911.23	912.81
36	927.10	928.69	930.28	931.86	933.45	935.04	936.63	938.21
37	952.50	954.09	955.68	957.26	958.85	960.44	962.03	963.61
38	977.90	979.49	981.08	982.66	984.25	985.84	987.43	989.01
39	1003.30	1004.89	1006.48	1008.06	1009.65	1011.24	1012.83	1014.41
40	1028.70	1030.29	1031.88	1033.46	1035.05	1036.64	1038.23	1039.81
41	1054.10	1055.69	1057.28	1058.86	1060.45	1062.04	1063.63	1065.21
42	1079.50	1081.09	1082.68	1084.26	1085.85	1087.44	1089.03	1090.61
43	1104.90	1106.49	1108.08	1109.66	1111.25	1112.84	1114.43	1116.01
44	1130.30	1131.89	1133.48	1135.06	1136.65	1138.24	1139.83	1141.41
45	1155.70	1157.29	1158.88	1160.46	1162.05	1163.64	1165.23	1166.81
46	1181.10	1182.69	1184.28	1185.86	1187.45	1189.04	1190.63	1192.21
47	1206.50	1208.09	1209.68	1211.26	1212.85	1214.44	1216.03	1217.61
48	1231.90	1233.49	1235.08	1236.66	1238.25	1239.84	1241.43	1243.01
49	1257.30	1258.89	1260.48	1262.06	1263.65	1265.24	1266.83	1268.41
50	1282.70	1284.29	1285.88	1287.46	1289.05	1290.64	1292.23	1293.81

METRIC CONVERSION TABLE

Pounds Avoirdupois to Kilograms

1 Pound=0.45359 Kilograms

Units / Tens	0	1	2	3	4	5	6	7	8	9
0		0.45	0.91	1.36	1.81	2.27	2.72	3.18	3.63	4.08
1	4.54	4.99	5.44	5.90	6.35	6.80	7.26	7.71	8.16	8.62
2	9.07	9.53	9.98	10.43	10.89	11.34	11.79	12.25	12.70	13.15
3	13.61	14.06	14.51	14.97	15.42	15.88	16.33	16.78	17.24	17.69
4	18.14	18.60	19.05	19.50	19.96	20.41	20.87	21.32	21.77	22.23
5	22.68	23.13	23.59	24.04	24.49	24.95	25.40	25.85	26.31	26.76
6	27.22	27.67	28.12	28.58	29.03	29.48	29.94	30.39	30.84	31.30
7	31.75	32.21	32.66	33.11	33.57	34.02	34.47	34.93	35.38	35.83
8	36.29	36.74	37.19	37.65	38.10	38.56	39.01	39.46	39.92	40.37
9	40.82	41.28	41.73	42.18	42.64	43.09	43.54	44.00	44.45	44.91
10	45.36	45.81	46.27	46.72	47.17	47.63	48.08	48.53	48.99	49.44
11	49.90	50.35	50.80	51.26	51.71	52.16	52.62	53.07	53.52	53.98
12	54.43	54.88	55.34	55.79	56.25	56.70	57.15	57.61	58.06	58.51
13	58.97	59.42	59.87	60.33	60.78	61.23	61.69	62.14	62.60	63.05
14	63.50	63.96	64.41	64.86	65.32	65.77	66.22	66.68	67.13	67.59
15	68.04	68.49	68.95	69.40	69.85	70.31	70.76	71.21	71.67	72.12
16	72.57	73.03	73.48	73.94	74.39	74.84	75.30	75.75	76.20	76.66
17	77.11	77.56	78.02	78.47	78.93	79.38	79.83	80.29	80.74	81.19
18	81.65	82.10	82.55	83.01	83.46	83.91	84.37	84.82	85.28	85.73
19	86.18	86.64	87.09	87.54	88.00	88.45	88.90	89.36	89.81	90.26
20	90.72	91.17	91.63	92.08	92.53	92.99	93.44	93.89	94.35	94.80
21	95.25	95.71	96.16	96.62	97.07	97.52	97.98	98.43	98.88	99.34
22	99.79	100.24	100.70	101.15	101.60	102.06	102.51	102.97	103.42	103.87
23	104.33	104.78	105.23	105.69	106.14	106.59	107.05	107.50	107.96	108.41
24	108.86	109.32	109.77	110.22	110.68	111.13	111.58	112.04	112.49	112.94
25	113.40	113.85	114.31	114.76	115.21	115.67	116.12	116.57	117.03	117.48
26	117.93	118.39	118.84	119.29	119.75	120.20	120.66	121.11	121.56	122.02
27	122.47	122.92	123.38	123.83	124.28	124.74	125.19	125.65	126.10	126.55
28	127.01	127.46	127.91	128.37	128.82	129.27	129.73	130.18	130.63	131.09
29	131.54	132.00	132.45	132.90	133.36	133.81	134.26	134.72	135.17	135.62
30	136.08	136.53	136.98	137.44	137.89	138.35	138.80	139.25	139.71	140.16
31	140.61	141.07	141.52	141.97	142.43	142.88	143.34	143.79	144.24	144.70
32	145.15	145.60	146.06	146.51	146.96	147.42	147.87	148.32	148.78	149.23
33	149.69	150.14	150.59	151.05	151.50	151.95	152.41	152.86	153.31	153.77
34	154.22	154.68	155.13	155.58	156.04	156.49	156.94	157.40	157.85	158.30
35	158.76	159.21	159.66	160.12	160.57	161.03	161.48	161.93	162.39	162.84
36	163.29	163.75	164.20	164.65	165.11	165.56	166.01	166.47	166.92	167.38
37	167.83	168.28	168.74	169.19	169.64	170.10	170.55	171.00	171.46	171.91
38	172.37	172.82	173.27	173.73	174.18	174.63	175.09	175.54	175.99	176.45
39	176.90	177.35	177.81	178.26	178.72	179.17	179.62	180.08	180.53	180.98
40	181.44	181.89	182.34	182.80	183.25	183.70	184.16	184.61	185.07	185.52
41	185.97	186.43	186.88	187.33	187.79	188.24	188.69	189.15	189.60	190.06
42	190.51	190.96	191.42	191.87	192.32	192.78	193.23	193.68	194.14	194.59
43	195.04	195.50	195.95	196.41	196.86	197.31	197.77	198.22	198.67	199.13
44	199.58	200.03	200.49	200.94	201.40	201.85	202.30	202.76	203.21	203.66
45	204.12	204.57	205.02	205.48	205.93	206.38	206.84	207.29	207.75	208.20
46	208.65	209.11	209.56	210.01	210.47	210.92	211.37	211.83	212.28	212.73
47	213.19	213.64	214.10	214.55	215.00	215.46	215.91	216.36	216.82	217.27
48	217.72	218.18	218.63	219.09	219.54	219.99	220.45	220.90	221.35	221.81
49	222.26	222.71	223.17	223.62	224.07	224.53	224.98	225.44	225.89	226.34

METRIC CONVERSION TABLE

Pounds Avoirdupois to Kilograms

1 Pound=0.45359 Kilograms

Tens \ Units	0	1	2	3	4	5	6	7	8	9
50	226.80	227.25	227.70	228.16	228.61	229.06	229.52	229.97	230.42	230.88
51	231.33	231.79	232.24	232.69	233.15	233.60	234.05	234.51	234.96	235.41
52	235.87	236.32	236.78	237.23	237.68	238.14	238.59	239.04	239.50	239.95
53	240.40	240.86	241.31	241.76	242.22	242.67	243.13	243.58	244.03	244.49
54	244.94	245.39	245.85	246.30	246.75	247.21	247.66	248.12	248.57	249.02
55	249.48	249.93	250.38	250.84	251.29	251.74	252.20	252.65	253.10	253.56
56	254.01	254.47	254.92	255.37	255.83	256.28	256.73	257.19	257.64	258.09
57	258.55	259.00	259.45	259.91	260.36	260.82	261.27	261.72	262.18	262.63
58	263.08	263.54	263.99	264.44	264.90	265.35	265.81	266.26	266.71	267.17
59	267.62	268.07	268.53	268.98	269.43	269.89	270.34	270.79	271.25	271.70
60	272.16	272.61	273.06	273.52	273.97	274.42	274.88	275.33	275.78	276.24
61	276.69	277.14	277.60	278.05	278.51	278.96	279.41	279.87	280.32	280.77
62	281.23	281.68	282.13	282.59	283.04	283.50	283.95	284.40	284.86	285.31
63	285.76	286.22	286.67	287.12	287.58	288.03	288.48	288.94	289.39	289.85
64	290.30	290.75	291.21	291.66	292.11	292.57	293.02	293.47	293.93	294.38
65	294.84	295.29	295.74	296.20	296.65	297.10	297.56	298.01	298.46	298.92
66	299.37	299.82	300.28	300.73	301.19	301.64	302.09	302.55	303.00	303.45
67	303.91	304.36	304.81	305.27	305.72	306.17	306.63	307.08	307.54	307.99
68	308.44	308.90	309.35	309.80	310.26	310.71	311.16	311.62	312.07	312.53
69	312.98	313.43	313.89	314.34	314.79	315.25	315.70	316.15	316.61	317.06
70	317.51	317.97	318.42	318.88	319.33	319.78	320.24	320.69	321.14	321.60
71	322.05	322.50	322.96	323.41	323.86	324.32	324.77	325.23	325.68	326.13
72	326.59	327.04	327.49	327.95	328.40	328.85	329.31	329.76	330.22	330.67
73	331.12	331.58	332.03	332.48	332.94	333.39	333.84	334.30	334.75	335.20
74	335.66	336.11	336.57	337.02	337.47	337.93	338.38	338.83	339.29	339.74
75	340.19	340.65	341.10	341.56	342.01	342.46	342.92	343.37	343.82	344.28
76	344.73	345.18	345.64	346.09	346.54	347.00	347.45	347.91	348.36	348.81
77	349.27	349.72	350.17	350.63	351.08	351.53	351.99	352.44	352.89	353.35
78	353.80	354.26	354.71	355.16	355.62	356.07	356.52	356.98	357.43	357.88
79	358.34	358.79	359.25	359.70	360.15	360.61	361.06	361.51	361.97	362.42
80	362.87	363.33	363.78	364.23	364.69	365.14	365.60	366.05	366.50	366.96
81	367.41	367.86	368.32	368.77	369.22	369.68	370.13	370.59	371.04	371.49
82	371.95	372.40	372.85	373.31	373.76	374.21	374.67	375.12	375.57	376.03
83	376.48	376.94	377.39	377.84	378.30	378.75	379.20	379.66	380.11	380.56
84	381.02	381.47	381.92	382.33	382.83	383.29	383.74	384.19	384.65	385.10
85	385.55	386.01	386.46	386.91	387.37	387.82	388.28	388.73	389.18	389.64
86	390.09	390.54	391.00	391.45	391.90	392.36	392.81	393.26	393.72	394.17
87	394.63	395.08	395.53	395.99	396.44	396.89	397.35	397.80	398.25	398.71
88	399.16	399.61	400.07	400.52	400.98	401.43	401.88	402.34	402.79	403.24
89	403.78	404.15	404.60	405.06	405.51	405.97	406.42	406.87	407.33	407.78
90	408.23	408.69	409.14	409.59	410.05	410.50	410.95	411.41	411.86	412.32
91	412.77	413.22	413.68	414.13	414.58	415.14	415.49	415.94	416.40	416.85
92	417.31	417.76	418.21	418.67	419.12	419.57	420.03	420.48	420.93	421.39
93	421.84	422.29	422.75	423.20	423.66	424.11	424.56	425.02	425.47	425.92
94	426.38	426.83	427.28	427.74	428.19	428.64	429.10	429.55	430.01	430.46
95	430.91	431.37	431.82	432.27	432.73	433.18	433.63	434.09	434.54	435.00
96	435.45	435.90	436.36	436.81	437.26	437.72	438.17	438.62	439.08	439.53
97	439.98	440.44	440.89	441.35	441.80	442.25	442.71	443.16	443.61	444.07
98	444.52	444.97	445.43	445.88	446.33	446.79	447.24	447.70	448.15	448.60
99	449.06	449.51	449.96	450.42	450.87	451.32	451.78	452.23	452.69	453.14

PROPERTIES OF THE CIRCLE

Circumference of Circle of Dia. $1 = \pi = 3.14159265$

Circumference of Circle $= 2\,\pi\,r$

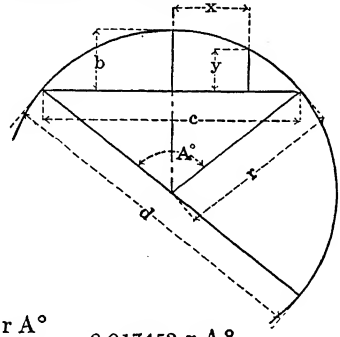
Dia. of Circle = Circumference x 0.31831

Diameter of Circle of equal periphery as square = side x 1.27324

Side of Square of equal periphery as circle = diameter x 0.78540

Diameter of Circle circumscribed about square = side x 1.41421

Side of Square inscribed in Circle = diameter x 0.70711



Arc, $a = \dfrac{\pi\,r\,A^\circ}{180} = 0.017453\,r\,A^\circ$

Angle, $A = \dfrac{180^\circ\,a}{\pi\,r} = 57.29578\,\dfrac{a}{r}$

Radius, $r = \dfrac{4\,b^2 + c^2}{8\,b}$ Diameter, $d = \dfrac{4\,b^2 + c^2}{4\,b}$

Chord, $c = 2\sqrt{2\,b\,r - b^2} = 2\,r\,\sin\dfrac{A^\circ}{2}$

Rise, $b = r - \tfrac{1}{2}\sqrt{4\,r^2 - c^2} = \dfrac{c}{2}\,\tan\dfrac{A^\circ}{4} = 2\,r\,\sin^2\dfrac{A}{4}$

Rise, $b = r + y - \sqrt{r^2 - x^2}$ $y = b - r + \sqrt{r^2 - x^2}$ $x = \sqrt{r^2 - (r + y - b)^2}$

$\pi = 3.14159265$, log $= 0.4971499$

$\dfrac{1}{\pi} = 0.3183099$, log $= \bar{1}.5028501$

$\pi^2 = 9.8696044$, log $= 0.9942997$

$\dfrac{1}{\pi^2} = 0.1013212$, log $= \bar{1}.0057003$

$\sqrt{\pi} = 1.7724539$, log $= 0.2485749$

$\sqrt{\dfrac{1}{\pi}} = 0.5641896$, log $= \bar{1}.7514251$

$\dfrac{\pi}{180} = 0.0174533$, log $= \bar{2}.2418774$

$\dfrac{180}{\pi} = 57.2957795$, log $= 1.7581226$

AREA OF PLANE FIGURES

Triangle: Base x ½ perpendicular height.

$\sqrt{s(s-a)\ (s-b)\ (s-c)}$,

$s = \frac{1}{2}$ sum of the three sides a, b and c.

Trapezium: Sum of area of the two triangles.

Trapezoid: ½ sum of parallel sides x perpendicular height.

Parallelogram: Base x perpendicular height.

Regular Polygon: ½ sum of sides x inside radius.

Circle: $\pi r^2 = 0.78540 \times \text{dia.}^2 = 0.07958 \times \text{circumference}^2$

Sector of Circle: $\frac{\pi r^2 A^\circ}{360} = 0.0087266\, r^2 A^\circ =$ arc x ½ radius.

Segment of Circle: $\frac{r^2}{2}\left(\frac{\pi A^\circ}{180} - \sin A^\circ\right)$

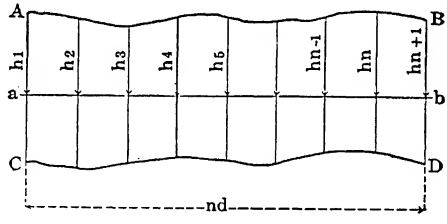
Circle of same area as square: diameter = side x 1.12838

Square of same area as circle: side = diameter x 0.88623

Ellipse: Long diameter x short diameter x 0.78540

Parabola: Base x ⅔ perpendicular height.

Irregular plane surface.

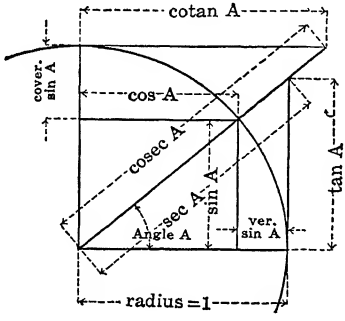


Divide any plane surface A, B, C, D, along a line a–b into an even number, n, of parallel and sufficiently small strips, d, whose ordinates are $h_1, h_2, h_3, h_4, h_5 \ldots h_{n-1}, h_n, h_{n+1}$, and considering contours between three ordinates as parabolic curves, then for section ABCD,

$$\text{Area} = \frac{d}{3}\left[h_1 + h_{n+1} + 4(h_2 + h_4 + h_6 \ldots + h_n) + 2(h_3 + h_5 + h_7 \ldots + h_{n-1})\right]$$

or, approximately, Area = Sum of ordinates x width, d.

TRIGONOMETRIC FORMULAS



Radius, $1 = \sin^2 A + \cos^2 A$

$= \sin A \operatorname{cosec} A = \cos A \sec A = \tan A \cot A$

Sine $A = \frac{\cos A}{\cot A} = \frac{1}{\operatorname{cosec} A} = \cos A \tan A = \sqrt{1 - \cos^2 A}$

Cosine $A = \frac{\sin A}{\tan A} = \frac{1}{\sec A} = \sin A \cot A = \sqrt{1 - \sin^2 A}$

Tangent $A = \frac{\sin A}{\cos A} = \frac{1}{\cot A} = \sin A \sec A$

Cotangent $A = \frac{\cos A}{\sin A} = \frac{1}{\tan A} = \cos A \operatorname{cosec} A$

Secant $A = \frac{\tan A}{\sin A} = \frac{1}{\cos A}$

Cosecant $A = \frac{\cot A}{\cos A} = \frac{1}{\sin A}$

$\sin (A \pm B) = \sin A \cos B \pm \cos A \sin B$

$\cos (A \pm B) = \cos A \cos B \mp \sin A \sin B$

$\sin A + \sin B = 2 \sin \frac{1}{2}(A + B) \cos \frac{1}{2}(A - B)$

$\sin A - \sin B = 2 \cos \frac{1}{2}(A + B) \sin \frac{1}{2}(A - B)$

$\cos A + \cos B = 2 \cos \frac{1}{2}(A + B) \cos \frac{1}{2}(A - B)$

$\cos B - \cos A = 2 \sin \frac{1}{2}(A + B) \sin \frac{1}{2}(A - B)$

$\sin 2A = 2 \sin A \cos A$

$\cos 2A = \cos^2 A - \sin^2 A$

$\sin \frac{1}{2} A = \sqrt{\frac{1 - \cos A}{2}}$ $\quad \cos \frac{1}{2} A = \sqrt{\frac{1 + \cos A}{2}}$

$\sin^2 A = \frac{1 - \cos 2A}{2}$ $\quad \cos^2 A = \frac{1 + \cos 2A}{2}$

$\sin^2 A - \sin^2 B = \sin (A + B) \sin (A - B)$

$\frac{\sin A \pm \sin B}{\cos A + \cos B} = \tan \frac{1}{2}(A \pm B)$

$\tan (A \pm B) = \frac{\tan A \pm \tan B}{1 \mp \tan A \tan B}$

$\cot (A \pm B) = \frac{\cot A \cot B \mp 1}{\cot B \pm \cot A}$

$\tan A + \tan B = \frac{\sin (A + B)}{\cos A \cos B}$

$\tan A - \tan B = \frac{\sin (A - B)}{\cos A \cos B}$

$\cot A + \cot B = \frac{\sin (B + A)}{\sin A \sin B}$

$\cot A - \cot B = \frac{\sin (B - A)}{\sin A \sin B}$

$\tan 2A = \frac{2 \tan A}{1 - \tan^2 A}$

$\cot 2A = \frac{\cot^2 A - 1}{2 \cot A}$

$\tan \frac{1}{2} A = \frac{\sin A}{1 + \cos A}$ $\quad \cot \frac{1}{2} A = \frac{\sin A}{1 - \cos A}$

$\tan^2 A = \frac{1 - \cos 2A}{1 + \cos 2A}$ $\quad \cot^2 A = \frac{1 + \cos 2A}{1 - \cos 2A}$

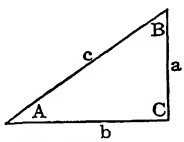
$\cos^2 A - \sin^2 B = \cos (A + B) \cos (A - B)$

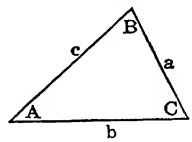
$\frac{\sin A \pm \sin B}{\cos B - \cos A} = \cot \frac{1}{2}(A \mp B)$

Quadrant	I	II	III	IV	Angle		
Angles	0° to 90°	90° to 180°	180° to 270°	270° to 360°	30°	45°	60°
Functions	Values vary from				Equivalent values		
sin	+0 to +1	+1 to +0	−0 to −1	−1 to −0	$\frac{1}{2}$	$\frac{1}{2}\sqrt{2}$	$\frac{1}{2}\sqrt{3}$
cos	+1 to +0	−0 to −1	−1 to −0	+0 to +1	$\frac{1}{2}\sqrt{3}$	$\frac{1}{2}\sqrt{2}$	$\frac{1}{2}$
tan	+0 to +∞	−∞ to −0	+0 to +∞	−∞ to −0	$\frac{1}{3}\sqrt{3}$	1	$\sqrt{3}$
cot	+∞ to +0	−0 to −∞	+∞ to +0	−0 to −∞	$\sqrt{3}$	1	$\frac{1}{3}\sqrt{3}$

Angle a < 90°				
Angle	sin	cos	tan	cot
$\phi°$	$\phi°$	$\phi°$	$\phi°$	$\phi°$
$0° \pm a$	$\pm \sin a$	$+\cos a$	$\pm \tan a$	$\pm \cot a$
$90° \pm a$	$+\cos a$	$\mp \sin a$	$\mp \cot a$	$\mp \tan a$
$180° \pm a$	$\mp \sin a$	$-\cos a$	$\pm \tan a$	$\pm \cot a$
$270° \pm a$	$-\cos a$	$\pm \sin a$	$\mp \cot a$	$\mp \tan a$

TRIGONOMETRIC SOLUTION OF TRIANGLES



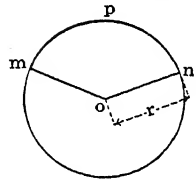


$S = \frac{a+b+c}{2}$

Given	Sought	Formulae
		Right-Angled Triangles
a, c	A, B, b	$\sin A = \frac{a}{c}$, $\cos B = \frac{a}{c}$, $b = \sqrt{c^2 - a^2}$
	Area	Area $= \frac{a}{2}\sqrt{c^2 - a^2}$
a, b	A, B, c	$\tan A = \frac{a}{b}$, $\tan B = \frac{b}{a}$, $c = \sqrt{a^2 + b^2}$
	Area	Area $= \frac{a\,b}{2}$
A, a	B, b, c	$B = 90° - A$, $b = a \cot A$, $c = \frac{a}{\sin A}$
	Area	Area $= \frac{a^2 \cot A}{2}$
A, b	B, a, c	$B = 90° - A$, $a = b \tan A$, $c = \frac{b}{\cos A}$
	Area	Area $= \frac{b^2 \tan A}{2}$
A, c	B, a, b	$B = 90° - A$, $a = c \sin A$, $b = c \cos A$
	Area	Area $= \frac{c^2 \sin A \cos A}{2}$ or $\frac{c^2 \sin 2A}{4}$
		Oblique-Angled Triangles
a, b, c	A	$\sin \frac{1}{2}A = \sqrt{\frac{(s-b)(s-c)}{b\,c}}$, $\cos \frac{1}{2}A = \sqrt{\frac{s(s-a)}{b\,c}}$, $\tan \frac{1}{2}A = \sqrt{\frac{(s-b)(s-c)}{s(s-a)}}$
	B	$\sin \frac{1}{2}B = \sqrt{\frac{(s-a)(s-c)}{a\,c}}$, $\cos \frac{1}{2}B = \sqrt{\frac{s(s-b)}{a\,c}}$, $\tan \frac{1}{2}B = \sqrt{\frac{(s-a)(s-c)}{s(s-b)}}$
	C	$\sin \frac{1}{2}C = \sqrt{\frac{(s-a)(s-b)}{a\,b}}$, $\cos \frac{1}{2}C = \sqrt{\frac{s(s-c)}{a\,b}}$, $\tan \frac{1}{2}C = \sqrt{\frac{(s-a)(s-b)}{s(s-c)}}$
	Area	Area $= \sqrt{s(s-a)(s-b)(s-c)}$
a, A, B	b, c	$b = \frac{a \sin B}{\sin A}$ $c = \frac{a \sin C}{\sin A} = \frac{a \sin (A+B)}{\sin A}$
	Area	Area $= \frac{1}{2} a\,b \sin C = \frac{a^2 \sin B \sin C}{2 \sin A}$
a, b, A	B	$\sin B = \frac{b \sin A}{a}$
	c	$c = \frac{a \sin C}{\sin A} = \frac{b \sin C}{\sin B} = \sqrt{a^2 + b^2 - 2\,ab \cos C}$
	Area	Area $= \frac{1}{2} a\,b \sin C$
a, b, C	A	$\tan A = \frac{a \sin C}{b - a \cos C}$, $\tan \frac{1}{2}(A-B) = \frac{a-b}{a+b} \cot \frac{1}{2}C$
	c	$c = \sqrt{a^2 + b^2 - 2\,ab \cos C} = \frac{a \sin C}{\sin A}$
	Area	Area $= \frac{1}{2} ab \sin C$

$a^2 = b^2 + c^2 - 2bc \cos A$, $b^2 = a^2 + c^2 - 2\,a\,c \cos B$ $c^2 = a^2 + b^2 - 2\,ab \cos C$

AREA OF CIRCULAR SECTIONS



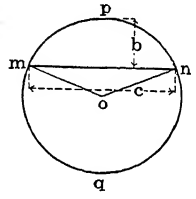
Circular Sector, m o n p

Area=½ (length of arc, m p n x radius, r)

$$=\text{area of circle} \times \frac{\text{arc, m p n, in degrees}}{360}$$

=0.0087266 x square of radius, r^2, x angle of arc, m p n, in degrees.

Circular Segment, m p n, less than half circle.



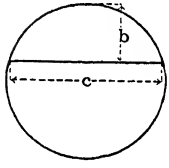
Area=area of sector, m o n p—area of triangle, m o n

$$=\frac{(\text{length of arc, m p n, x radius, r}) - (\text{radius, r, } - \text{rise, b}) \times \text{chord, c}}{2}$$

Circular Segment, m q n, greater than half circle.

Area=area of circle—area of segment, m n p

Circular Segment, from Table I, page 143.



Given: rise, b, and chord, c.

Area=product of rise and chord, b x c, multiplied by the coefficient given opposite the quotient of $\frac{b}{c}$:

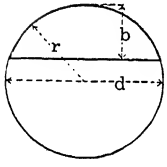
Intermediate coefficients for values of $\frac{b}{c}$ not given in tables are obtained by interpolation,

Example—Given: rise=1.49 and chord=3.52,

$\frac{b}{c} = \frac{1.49}{3.52} = 0.4233$. Coefficient=0.7542.

Area=b x c x coeff.=1.49 x 3.52 x 0.7542=3.9556.

Circular Segment from Table II, pages 144 and 145.



Given: rise, b, and diameter, d=2r.

Area=square of diameter, d^2, multiplied by the coefficient given opposite the quotient of $\frac{b}{d}$.

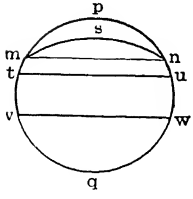
Intermediate coefficients for values of $\frac{b}{d}$ not given in tables are obtained by interpolation.

Example—Given: rise=2 7/16 and diameter=5 3/32.

$\frac{b}{d}$ =2 7/16 ÷ 5 3/32=0.478528.

Coefficient by interpolation=0.371233.

Area=d^2 x coeff. = 25.94629 x 0.371233=9.6321.



Circular Zone, t u w v

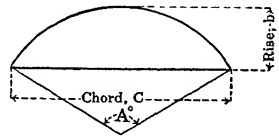
Area=area of circle—(area of segment, t p u + area of segment, v q w).

Circular Lune, m p n s

Area=segment, m p n—segment, m s n.

AREAS OF CIRCULAR SEGMENTS

Table 1—For Ratios of Rise and Chord

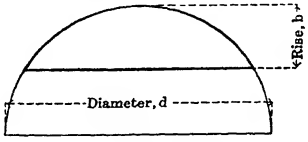


Area=C x b x coefficient

A°	Coefficient	$\frac{b}{C}$	A°	Coefficient	$\frac{b}{C}$	A°	Coefficient	$\frac{b}{C}$	A°	Coefficient	$\frac{b}{C}$
1	.6667	.0022	46	.6722	.1017	91	.6895	.2097	136	.7239	.3373
2	.6667	.0044	47	.6724	.1040	92	.6901	.2122	137	.7249	.3404
3	.6667	.0066	48	.6727	.1063	93	.6906	.2148	138	.7260	.3436
4	.6667	.0087	49	.6729	.1086	94	.6912	.2174	139	.7270	.3469
5	.6667	.0109	50	.6732	.1109	95	.6918	.2200	140	.7281	.3501
6	.6667	.0131	51	.6734	.1131	96	.6924	.2226	141	.7292	.3534
7	.6668	.0153	52	.6737	.1154	97	.6930	.2252	142	.7303	.3567
8	.6668	.0175	53	.6740	.1177	98	.6936	.2279	143	.7314	.3600
9	.6669	.0197	54	.6743	.1200	99	.6942	.2305	144	.7325	.3633
10	.6670	.0218	55	.6746	.1224	100	.6948	.2332	145	.7336	.3666
11	.6670	.0240	56	.6749	.1247	101	.6954	.2358	146	.7348	.3700
12	.6671	.0262	57	.6752	.1270	102	.6961	.2385	147	.7360	.3734
13	.6672	.0284	58	.6755	.1293	103	.6967	.2412	148	.7372	.3768
14	.6672	.0306	59	.6758	.1316	104	.6974	.2439	149	.7384	.3802
15	.6673	.0328	60	.6761	.1340	105	.6980	.2466	150	.7396	.3837
16	.6674	.0350	61	.6764	.1363	106	.6987	.2493	151	.7408	.3871
17	.6674	.0372	62	.6768	.1387	107	.6994	.2520	152	.7421	.3906
18	.6675	.0394	63	.6771	.1410	108	.7001	.2548	153	.7434	.3942
19	.6676	.0416	64	.6775	.1434	109	.7008	.2575	154	.7447	.3977
20	.6677	.0437	65	.6779	.1457	110	.7015	.2603	155	.7460	.4013
21	.6678	.0459	66	.6782	.1481	111	.7022	.2631	156	.7473	.4049
22	.6679	.0481	67	.6786	.1505	112	.7030	.2659	157	.7486	.4085
23	.6680	.0504	68	.6790	.1529	113	.7037	.2687	158	.7500	.4122
24	.6681	.0526	69	.6794	.1553	114	.7045	.2715	159	.7514	.4159
25	.6682	.0548	70	.6797	.1577	115	.7052	.2743	160	.7528	.4196
26	.6684	.0570	71	.6801	.1601	116	.7060	.2772	161	.7542	.4233
27	.6685	.0592	72	.6805	.1625	117	.7068	.2800	162	.7557	.4270
28	.6687	.0614	73	.6809	.1649	118	.7076	.2829	163	.7571	.4308
29	.6688	.0636	74	.6814	.1673	119	.7084	.2858	164	.7586	.4346
30	.6690	.0658	75	.6818	.1697	120	.7092	.2887	165	.7601	.4385
31	.6691	.0681	76	.6822	.1722	121	.7100	.2916	166	.7616	.4424
32	.6693	.0703	77	.6826	.1746	122	.7109	.2945	167	.7632	.4463
33	.6694	.0725	78	.6831	.1771	123	.7117	.2975	168	.7648	.4502
34	.6696	.0747	79	.6835	.1795	124	.7126	.3004	169	.7664	.4542
35	.6698	.0770	80	.6840	.1820	125	.7134	.3034	170	.7680	.4582
36	.6700	.0792	81	.6844	.1845	126	.7143	.3064	171	.7696	.4622
37	.6702	.0814	82	.6849	.1869	127	.7152	.3094	172	.7712	.4663
38	.6704	.0837	83	.6854	.1894	128	.7161	.3124	173	.7729	.4704
39	.6706	.0859	84	.6859	.1919	129	.7170	.3155	174	.7746	.4745
40	.6708	.0882	85	.6864	.1944	130	.7180	.3185	175	.7763	.4787
41	.6710	.0904	86	.6869	.1970	131	.7189	.3216	176	.7781	.4828
42	.6712	.0927	87	.6874	.1995	132	.7199	.3247	177	.7799	.4871
43	.6714	.0949	88	.6879	.2020	133	.7209	.3278	178	.7817	.4914
44	.6717	.0972	89	.6884	.2046	134	.7219	.3309	179	.7835	.4957
45	.6719	.0995	90	.6890	.2071	135	.7229	.3341	180	.7854	.5000

AREAS OF CIRCULAR SEGMENTS

Table II, for Ratios of Rise and Diameter

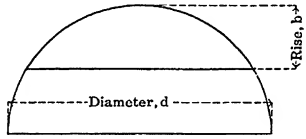


Area=d^2 x Coefficient

$\frac{b}{d}$	Coefficient	$\frac{b}{d}$	Coefficient	$\frac{b}{d}$	Coefficient	$\frac{b}{d}$	Coefficient	$\frac{b}{d}$	Coefficient
.001	.000042	.051	.015119	.101	.041477	.151	.074590	.201	.112625
.002	.000119	.052	.015561	.102	.042081	.152	.075307	.202	.113427
.003	.000219	.053	.016008	.103	.042687	.153	.076026	.203	.114231
.004	.000337	.054	.016458	.104	.043296	.154	.076747	.204	.115036
.005	.000471	.055	.016912	.105	.043908	.155	.077470	.205	.115842
.006	.000619	.056	.017369	.106	.044523	.156	.078194	.206	.116651
.007	.000779	.057	.017831	.107	.045140	.157	.078921	.207	.117460
.008	.000952	.058	.018297	.108	.045759	.158	.079650	.208	.118271
.009	.001135	.059	.018766	.109	.046381	.159	.080380	.209	.119084
.010	.001329	.060	.019239	.110	.047006	.160	.081112	.210	.119898
.011	.001533	.061	.019716	.111	.047633	.161	.081847	.211	.120713
.012	.001746	.062	.020197	.112	.048262	.162	.082582	.212	.121530
.013	.001969	.063	.020681	.113	.048894	.163	.083320	.213	.122348
.014	.002199	.064	.021168	.114	.049529	.164	.084060	.214	.123167
.015	.002438	.065	.021660	.115	.050165	.165	.084801	.215	.123988
.016	.002685	.066	.022155	.116	.050805	.166	.085545	.216	.124811
.017	.002940	.067	.022653	.117	.051446	.167	.086290	.217	.125634
.018	.003202	.068	.023155	.118	.052090	.168	.087037	.218	.126459
.019	.003472	.069	.023660	.119	.052737	.169	.087785	.219	.127286
.020	.003749	.070	.024168	.120	.053385	.170	.088536	.220	.128114
.021	.004032	.071	.024680	.121	.054037	.171	.089288	.221	.128943
.022	.004322	.072	.025196	.122	.054690	.172	.090042	.222	.129773
.023	.004619	.073	.025714	.123	.055346	.173	.090797	.223	.130605
.024	.004922	.074	.026236	.124	.056004	.174	.091555	.224	.131438
.025	.005231	.075	.026761	.125	.056664	.175	.092314	.225	.132273
.026	.005546	.076	.027290	.126	.057327	.176	.093074	.226	.133109
.027	.005867	.077	.027821	.127	.057991	.177	.093837	.227	.133946
.028	.006194	.078	.028356	.128	.058658	.178	.094601	.228	.134784
.029	.006527	.079	.028894	.129	.059328	.179	.095367	.229	.135624
.030	.006866	.080	.029435	.130	.059999	.180	.096135	.230	.136465
.031	.007209	.081	.029979	.131	.060673	.181	.096904	.231	.137307
.032	.007559	.082	.030526	.132	.061349	.182	.097675	.232	.138151
.033	.007913	.083	.031077	.133	.062027	.183	.098447	.233	.138996
.034	.008273	.084	.031630	.134	.062707	.184	.099221	.234	.139842
.035	.008638	.085	.032186	.135	.063389	.185	.099997	.235	.140689
.036	.009008	.086	.032746	.136	.064074	.186	.100774	.236	.141538
.037	.009383	.087	.033308	.137	.064761	.187	.101553	.237	.142388
.038	.009764	.088	.033873	.138	.065449	.188	.102334	.238	.143239
.039	.010148	.089	.034441	.139	.066140	.189	.103116	.239	.144091
.040	.010538	.090	.035012	.140	.066833	.190	.103900	.240	.144945
.041	.010932	.091	.035586	.141	.067528	.191	.104686	.241	.145800
.042	.011331	.092	.036162	.142	.068225	.192	.105472	.242	.146656
.043	.011734	.093	.036742	.143	.068924	.193	.106261	.243	.147513
.044	.012142	.094	.037324	.144	.069626	.194	.107051	.244	.148371
.045	.012555	.095	.037909	.145	.070329	.195	.107843	.245	.149231
.046	.012971	.096	.038497	.146	.071034	.196	.108636	.246	.150091
.047	.013393	.097	.039087	.147	.071741	.197	.109431	.247	.150953
.048	.013818	.098	.039681	.148	.072450	.198	.110227	.248	.151816
.049	.014248	.099	.040277	.149	.073162	.199	.111025	.249	.152681
.050	.014681	.100	.040875	.150	.073875	.200	.111824	.250	.153546

AREAS OF CIRCULAR SEGMENTS

TABLE II, FOR RATIOS OF RISE AND DIAMETER—Concluded

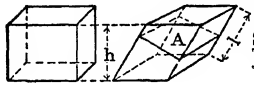


Area=d^2 x coefficient

$\frac{b}{d}$	Coefficient	$\frac{b}{d}$	Coefficient	$\frac{b}{d}$	Coefficient	$\frac{b}{d}$	Coefficient	$\frac{b}{d}$	Coefficient
.251	.154413	.301	.199085	.351	.245935	.401	.294350	.451	.343778
.252	.155281	.302	.200003	.352	.246890	.402	.295330	.452	.344773
.253	.156149	.303	.200922	.353	.247845	.403	.296311	.453	.345768
.254	.157019	.304	.201841	.354	.248801	.404	.297292	.454	.346764
.255	.157891	.305	.202762	.355	.249758	.405	.298274	.455	.347760
.256	.158763	.306	.203683	.356	.250715	.406	.299256	.456	.348756
.257	.159636	.307	.204605	.357	.251673	.407	.300238	.457	.349752
.258	.160511	.308	.205528	.358	.252632	.408	.301221	.458	.350749
.259	.161386	.309	.206452	.359	.253591	.409	.302204	.459	.351745
.260	.162263	.310	.207376	.360	.254551	.410	.303187	.460	.352742
.261	.163141	.311	.208302	.361	.255511	.411	.304171	.461	.353739
.262	.164020	.312	.209228	.362	.256472	.412	.305156	.462	.354736
.263	.164900	.313	.210155	.363	.257433	.413	.306140	.463	.355733
.264	.165781	.314	.211083	.364	.258395	.414	.307125	.464	.356730
.265	.166663	.315	.212011	.365	.259358	.415	.308110	.465	.357728
.266	.167546	.316	.212941	.366	.260321	.416	.309096	.466	.358725
.267	.168431	.317	.213871	.367	.261285	.417	.310082	.467	.359723
.268	.169316	.318	.214802	.368	.262249	.418	.311068	.468	.360721
.269	.170202	.319	.215734	.369	.263214	.419	.312055	.469	.361719
.270	.171090	.320	.216666	.370	.264179	.420	.313042	.470	.362717
.271	.171978	.321	.217600	.371	.265145	.421	.314029	.471	.363715
.272	.172868	.322	.218534	.372	.266111	.422	.315017	.472	.364714
.273	.173758	.323	.219469	.373	.267078	.423	.316005	.473	.365712
.274	.174650	.324	.220404	.374	.268046	.424	.316993	.474	.366711
.275	.175542	.325	.221341	.375	.269014	.425	.317981	.475	.367710
.276	.176436	.326	.222278	.376	.269982	.426	.318970	.476	.368708
.277	.177330	.327	.223216	.377	.270951	.427	.319959	.477	.369707
.278	.178226	.328	.224154	.378	.271921	.428	.320949	.478	.370706
.279	.179122	.329	.225094	.379	.272891	.429	.321938	.479	.371705
.280	.180020	.330	.226034	.380	.273861	.430	.322928	.480	.372704
.281	.180918	.331	.226974	.381	.274832	.431	.323919	.481	.373704
.282	.181818	.332	.227916	.382	.275804	.432	.324909	.482	.374703
.283	.182718	.333	.228858	.383	.276776	.433	.325900	.483	.375702
.284	.183619	.334	.229801	.384	.277748	.434	.326891	.484	.376702
.285	.184522	.335	.230745	.385	.278721	.435	.327883	.485	.377701
.286	.185425	.336	.231689	.386	.279695	.436	.328874	.486	.378701
.287	.186329	.337	.232634	.387	.280669	.437	.329866	.487	.379701
.288	.187235	.338	.233580	.388	.281643	.438	.330858	.488	.380700
.289	.188141	.339	.234526	.389	.282618	.439	.331851	.489	.381700
.290	.189048	.340	.235473	.390	.283593	.440	.332843	.490	.382700
.291	.189956	.341	.236421	.391	.284569	.441	.333836	.491	.383700
.292	.190865	.342	.237369	.392	.285545	.442	.334829	.492	.384699
.293	.191774	.343	.238319	.393	.286521	.443	.335823	.493	.385699
.294	.192685	.344	.239268	.394	.287499	.444	.336816	.494	.386699
.295	.193597	.345	.240219	.395	.288476	.445	.337810	.495	.387699
.296	.194509	.346	.241170	.396	.289454	.446	.338804	.496	.388699
.297	.195423	.347	.242122	.397	.290432	.447	.339799	.497	.389699
.298	.196337	.348	.243074	.398	.291411	.448	.340793	.498	.390699
.299	.197252	.349	.244027	.399	.292390	.449	.341788	.499	.391699
.300	.198168	.350	.244980	.400	.293370	.450	.342783	.500	.392699

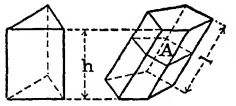
SURFACE AND VOLUME OF SOLIDS

S=Lateral or Convex Surface. V=Volume



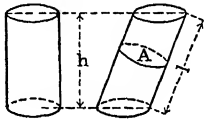
Parallelopiped

S=perimeter, P, perp. to sides x lat. length, l: P l
V=area of base, B x perpendicular height, h: Bh
V=area of section, A, perp. to sides x lat. length, l: Al



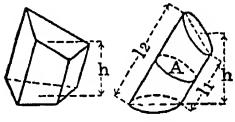
Prism, Right or Oblique, Regular or Irregular

S=perimeter, P, perp. to sides x lat. length, l: Pl
V=area of base, B x perpendicular height, h: Bh
V=area of section, A, perp. to sides x lat. length, l: Al



Cylinder, Right or Oblique, Circular or Elliptic, etc.

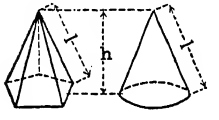
S=perimeter of base, P x perp. height, h: Ph
S=perimeter, P_1, perp. to sides x lat. length, l: $P_1 l$
V=area of base, B x perpendicular height, h: Bh
V=area of section, A, perp. to sides x lat. length, l: Al



Frustum of any Prism or Cylinder

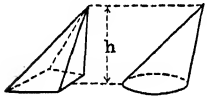
V=area of base, B x perp. distance, h, from base to center of gravity of opposite face: Bh

For cylinder: $\frac{1}{2} A (l_1 + l_2)$



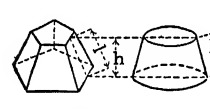
Pyramid or Cone, Right and Regular

S=perimeter of base, P x ½ slant height, l: ½ Pl
V=area of base, B x ⅓ perp. height, h: ⅓ Bh



Pyramid or Cone, Right or Oblique, Regular or Irregular

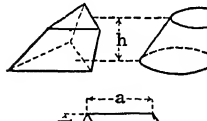
V=area of base, B x ⅓ perp. height, h: ⅓ Bh
V=⅓ volume of prism or cylinder of same base and perpendicular height
V=½ volume of hemisphere of same base and perpendicular height



Frustum of Pyramid or Cone, Right and Regular, Parallel Ends

S=(sum of perimeter of base, P, and top, p) x ½ slant height, l: ½ l (P + p)
V=(sum of areas of base, B, and top, b + square root of their products) x ⅓ perp. height, h:

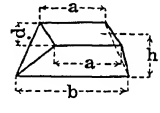
$$\frac{1}{3} h \left(B + b + \sqrt{B\,b}\right)$$



Frustum of any Pyramid or Cone, Parallel Ends

V=(sum of areas of base, B, and top, b + square root of their products) x ⅓ perp. height, h:

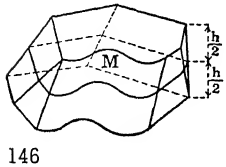
$$\frac{1}{3} h \left(B + b + \sqrt{B\,b}\right)$$



Wedge, Parallelogram Face

V=⅙ (sum of three edges, a b a x perpendicular height, h x perpendicular width, d):

$$\frac{1}{6} d h (2a + b)$$



Prismatoid

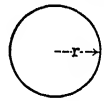
V=⅙ perp. height, h (sum of areas of base, B, and top b, + 4 x area of section, M, parallel to bases and midway between them):

$$\frac{1}{6} h (B + b + 4 M)$$

The Prismatoid formula applies also to any of the foregoing solids with parallel bases, to pyramids, cones, spherical sections, and to many solids with irregular surfaces.

SURFACE AND VOLUME OF SOLIDS—Concluded

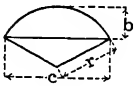
S=Lateral or Convex Surface. V=Volume



Sphere

$S = 4\ \pi\ r^2 = \quad \pi\ d^2 = 3.14159265\ d^2$

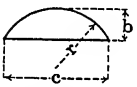
$V = 4/3\ \pi\ r^3 = 1/6\ \pi\ d^3 = 0.52359878\ d^3$



Spherical Sector

$S = 1/2\ \pi\ r\ (4\ b + c)$

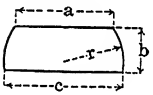
$V = 2/3\ \pi\ r^2\ b$



Spherical Segment

$S = 2\ \pi\ r\ b = 1/4\ \pi\ (4\ b^2 + c^2)$

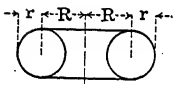
$V = 1/3\ \pi\ b^2\ (3\ r - b) = 1/24\ \pi\ b\ (3\ c^2 + 4\ b^2)$



Spherical Zone

$S = 2\ \pi\ r\ b$

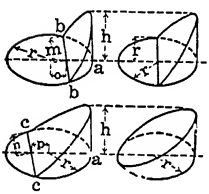
$V = 1/24\ \pi\ b\ (3\ a^2 + 3\ c^2 + 4\ b^2)$



Circular Ring

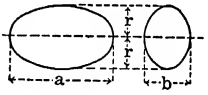
$S = 4\ \pi^2\ R\ r$

$V = 2\ \pi^2\ R\ r^2$

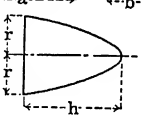


Ungula of Right, Regular Cylinder

Base=Segment, b a b	Base=Half Circle
$S = (2\ r\ m - o \times \text{arc, b a b}) \frac{h}{r-o}$	$S = 2\ r\ h$
$V = (2/3\ m^3 - o \times \text{area, b a b}) \frac{h}{r-o}$	$V = 2/3\ r^2\ h$
Base=Segment, c a c	Base=Circle
$S = (2\ r\ n + p \times \text{arc, c a c}) \frac{h}{r+p}$	$S = r\ \pi\ h$
$V = (2/3\ n^3 + p \times \text{area, c a c}) \frac{h}{r+p}$	$V = 1/2\ r^2\ \pi\ h$

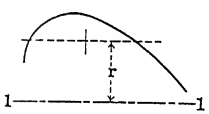


$V = 1/3\ \pi\ r\ a\ b$ **Ellipsoid**



$V = 1/2\ \pi\ r^2\ h$ **Paraboloid**

Ratio of corresponding volumes of a Cone, Paraboloid, Sphere, and Cylinder of equal height: 1/3: 1/2: 2/3: **1**



Bodies Generated by Partial or Complete Revolution

l=length of a curve } rotating about an axis 1-1
A=area of a plane } on one side and in plane of axis
r=distance of center of gravity of line or plane from axis 1-1 and for any angle of revolution, a°,

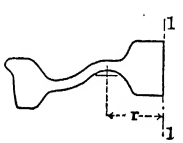
$\frac{2\ r\ \pi\ a^\circ}{360}$ =length of arc described by center of gravity.

S=length of curve x length of arc about axis

$= l\ \frac{2\ r\ \pi\ a^\circ}{360}$ For complete revolution $S = 2\ r\ \pi\ l$

V=area of plane x length of arc about axis

$= A\ \frac{2\ r\ \pi\ a^\circ}{360}$ For complete revolution $V = 2\ r\ \pi\ A$

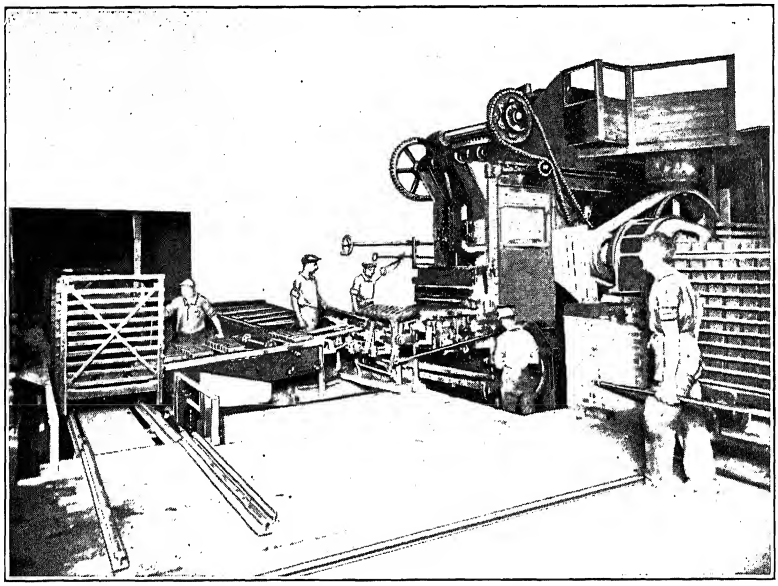


FUNCTIONS OF NUMBERS, 1 TO 49

No.	Square	Cube	Square Root	Cubic Root	Logarithm	1000 x Reciprocal	No. = Diameter	
							Circum.	Area
1	1	1	1.0000	1.0000	0.00000	1000.000	3.142	0.7854
2	4	8	1.4142	1.2599	0.30103	500.000	6.283	3.1416
3	9	27	1.7321	1.4422	0.47712	333.333	9.425	7.0686
4	16	64	2.0000	1.5874	0.60206	250.000	12.566	12.5664
5	25	125	2.2361	1.7100	0.69897	200.000	15.708	19.6350
6	36	216	2.4495	1.8171	0.77815	166.667	18.850	28.2743
7	49	343	2.6458	1.9129	0.84510	142.857	21.991	38.4845
8	64	512	2.8284	2.0000	0.90309	125.000	25.133	50.2655
9	81	729	3.0000	2.0801	0.95424	111.111	28.274	63.6173
10	100	1000	3.1623	2.1544	1.00000	100.000	31.416	78.5398
11	121	1331	3.3166	2.2240	1.04139	90.9091	34.558	95.0332
12	144	1728	3.4641	2.2894	1.07918	83.3333	37.699	113.097
13	169	2197	3.6056	2.3513	1.11394	76.9231	40.841	132.732
14	196	2744	3.7417	2.4101	1.14613	71.4286	43.982	153.938
15	225	3375	3.8730	2.4662	1.17609	66.6667	47.124	176.715
16	256	4096	4.0000	2.5198	1.20412	62.5000	50.265	201.062
17	289	4913	4.1231	2.5713	1.23045	58.8235	53.407	226.980
18	324	5832	4.2426	2.6207	1.25527	55.5556	56.549	254.469
19	361	6859	4.3589	2.6684	1.27875	52.6316	59.690	283.529
20	400	8000	4.4721	2.7144	1.30103	50.0000	62.832	314.159
21	441	9261	4.5826	2.7589	1.32222	47.6190	65.973	346.361
22	484	10648	4.6904	2.8020	1 34242	45.4545	69.115	380.133
23	529	12167	4.7958	2.8439	1.36173	43.4783	72.257	415.476
24	576	13824	4.8990	2.8845	1.38021	41.6667	75.398	452.389
25	625	15625	5.0000	2.9240	1.39794	40.0000	78.540	490.874
26	676	17576	5.0990	2.9625	1.41497	38.4615	81.681	530.929
27	729	19683	5.1962	3.0000	1.43136	37.0370	84.823	572.555
28	784	21952	5.2915	3.0366	1.44716	35.7143	87.965	615.752
29	841	24389	5.3852	3.0723	1.46240	34.4828	91.106	660.520
30	900	27000	5.4772	3.1072	1.47712	33.3333	94.248	706.858
31	961	29791	5.5678	3.1414	1.49136	32.2581	97.389	754.768
32	1024	32768	5.6569	3.1748	1.50515	31.2500	100.531	804.248
33	1089	35937	5.7446	3.2075	1.51851	30.3030	103.673	855.299
34	1156	39304	5.8310	3.2396	1.53148	29.4118	106.814	907.920
35	1225	42875	5.9161	3.2711	1.54407	28.5714	109.056	962.113
36	1296	46656	6.0000	3.3019	1.55630	27.7778	113.097	1017.88
37	1369	50653	6.0828	3.3322	1.56820	27.0270	116.239	1075.21
38	1444	54872	6.1644	3.3620	1.57978	26.3158	119.381	1134.11
39	1521	59319	6.2450	3.3912	1.59106	25.6410	122.522	1194.59
40	1600	64000	6.3246	3.4200	1.60206	25.0000	125.66	1256.64
41	1681	68921	6.4031	3.4482	1.61278	24.3902	128.81	1320.25
42	1764	74088	6.4807	3.4760	1.62325	23.8095	131.95	1385.44
43	1849	79507	6.5574	3.5034	1.63347	23.2558	135.09	1452.20
44	1936	85184	6.6332	3.5303	1.64345	22.7273	138.23	1520.53
45	2025	91125	6.7082	3.5569	1.65321	22.2222	141.37	1590.43
46	2116	97336	6.7823	3.5830	1.66276	21.7391	144.51	1661.90
47	2209	103823	6.8557	3.6088	1.67210	21.2766	147.65	1734.94
48	2304	110592	6.9282	3.6342	1.68124	20.8333	150.80	1809.56
49	2401	117649	7.0000	3.6593	1.69020	20.4082	153.94	1885.74

Lancaster

BRICK MACHINERY AND BRICK PLANT SUPPLIES

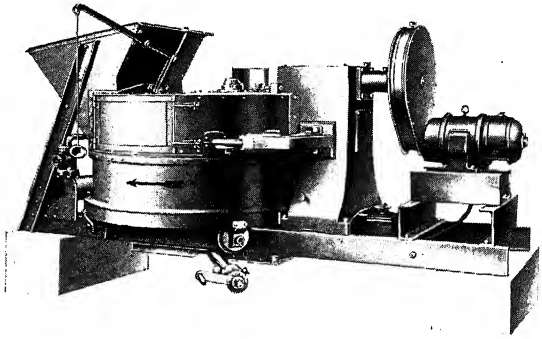


An AutoBrik Machine and Automatic Pallet Car Loader in Operation.

We manufacture complete equipment for the brick plant. In addition to the famous AutoBrik Machine and Automatic Pallet Car Loader illustrated above, we also furnish Hand Operated Brick Machines — Clay Cleaners — Granulators — Pug Mills — Disintegrators — Crushers — Sand Dryers — Belt Conveyors — Sand Grinder and Sifters — Brick Molds — Barrows and Trucks — Steam Pipe Rack Brick Dryers, and the "Lancaster" Brick Grab.

Lancaster

COUNTER-CURRENT RAPID BATCH MIXER



"Lancaster" Mixer Fitted with Closed Pan, Stationary Hopper, and the Famous Central Discharge Valve.

The "Lancaster" Counter-Current Rapid Batch Mixing System is scientific. It definitely charts the course the ingredients of a batch must follow until uniformly and completely blended. It has been developed from data obtained after several years of intensive scientific research into diversified mixing processes.

"Lancaster" Mixers have now definitely proved their value in the Abrasive — Ceramic — Refractory — Glass — Vitreous Enamel — Welding Rod — Foundry — Chemical — Concrete — Battery, and other diversified industries. Many large Universities and leading Research Laboratories have adopted the "Lancaster" Mixing System for developing new formulas.

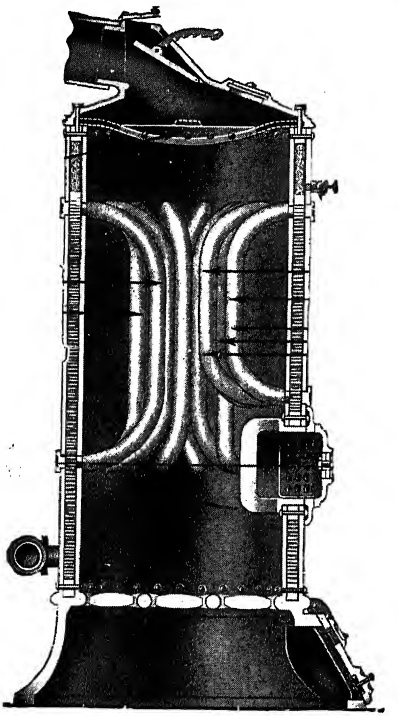
MIX BETTER AND QUICKER WITH A "LANCASTER"

MONITOR STEEL BOILERS

FOR STEAM, VAPOR AND HOT WATER HEATING CONSTRUCTED FOR BURNING COAL, GAS OR OIL AS FUEL

Monitor "U" Tube Boilers have been in use since 1888 and thousands of Monitor Boiler installations are still giving good service after many years usage under severe conditions.

These Boilers are manufactured and distributed from our plant in Lancaster, Pa., and are furnished in many sizes for Residences, Churches, Apartments, Schools, Garages, etc.



"The U-Tube does it"

Scientific construction and the use of the finest materials obtainable has given Monitor Boilers an enviable reputation for fuel economy, durability and reliability. The sturdy steel shell is constructed of the best steel boiler plate similar to the material used for high pressure boilers. The "U" Tubes are of the highest grade Charcoal Iron such as is standard in locomotive construction. The base, grates, smoke-hood, dome and baffle plate are of cast iron and no part of the steel shell comes in contact with the floor of cellar or foundation.

Adaptability to Oil Burning. The Monitor Boiler is ideally designed for the burning of oil. The steel shell and tubes will stand the sudden flash of a hot flame and each "U" shaped Tube, being a separate circulating medium and in direct contact with the flame of an oil burner assure rapid circulation and quick steaming. The base of the Monitor Boiler is so constructed that the installation of an oil burner can be made with little effort.

When special requirements are needed we can construct boilers for any specified pressure, built in accordance with the A. S. M. E. and State Code.

Send for Bulletin containing sizes and general information, if interested.

FOUNDRY DIVISION

Lancaster's complete modern foundry furnishes:

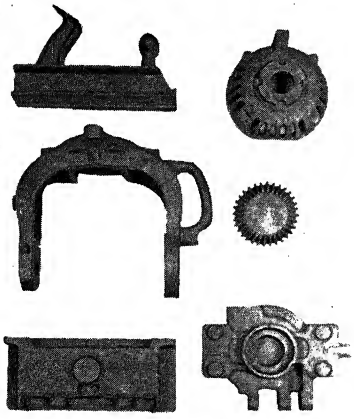
GRAY IRON CASTINGS OF EVERY DESCRIPTION

HEAT RESISTING ABRASIVE RESISTANT HIGH STRENGTH CASTINGS

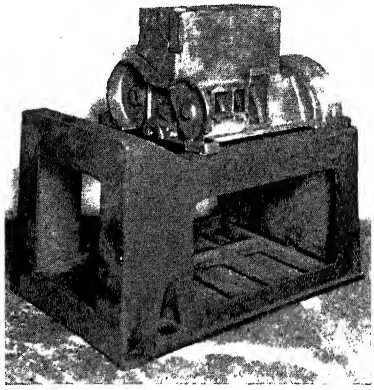
SEMI-STEEL FERROUS ALLOY CASTINGS

We are equipped to produce iron castings from pocket size to 8,000 pounds. Our modern core ovens, molding machines and cleaning equipment enables us to produce castings with smooth surface and close grain and that are readily machinable.

Our Pattern Shop is operated in connection with Foundry and produces Wood Patterns of every size.



Miscellaneous Small Castings



Diesel Engine Base and Block

MANHOLES, DOORS, FRAMES, STOP BOX COVERS, BOILER GRATES, VAULT COVERS, KILN CASTINGS, GEARS, CONVEYOR STANDS, ELEVATOR BOOTS, HUB GUARDS, SPOUT SHOES, SEWER TRAPS, HEAVY AND LIGHT INDUSTRIAL CASTINGS, ORNAMENTAL URNS, LAWN BENCHES, ETC.

LANCASTER RESEARCH LABORATORIES

DIVISION OF LANCASTER IRON WORKS, INC.

LOCATION: 85 ZABRISKIE ST., HACKENSACK, N. J.

Physical and Chemical Tests of Sewages, Sludges and Industrial Wastes. Examinations, Tests and Reports on Treatment Processes and Equipment. Experts in Litigation.

Treatment Processes for Industrial Wastes.

Steel plate construction has been employed in sewage practice for a number of years, exhibiting durability and freedom from spalling, cracking and repair. Many tanks supplied by us have been in constant service for over thirty years. Factory-fabricated sewage treatment plants to accommodate small load requirements have long intrigued the imagination of sanitary engineers and the alluring possibilities of such ready-to-assemble units have been frequently discussed.

Within the past year this idea materialized in a line of "Package Delivery" waste treatment plant units manufactured by Lancaster. The various units regularly supplied include:

PRIMARY TREATMENT UNITS (Imhoff or plain sedimentation tanks)

SECONDARY TREATMENT UNITS (oxidized sludge aerator-clarifier tanks)

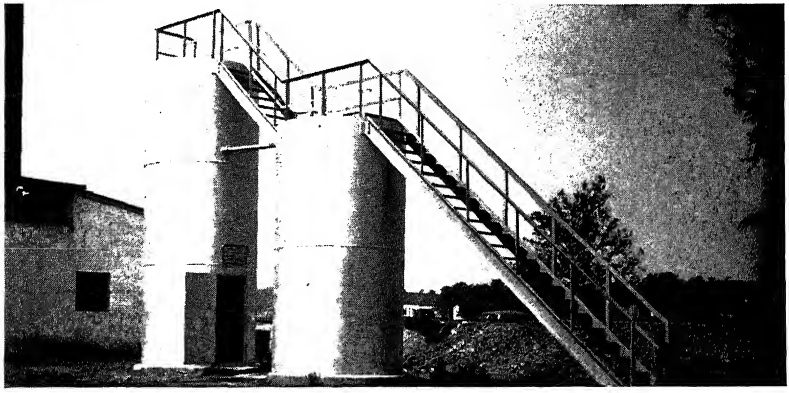
THIRD STAGE TREATMENT UNITS (chemical coagulation and chlorine sterilization tanks)

SEPARATE SLUDGE DIGESTION TANKS

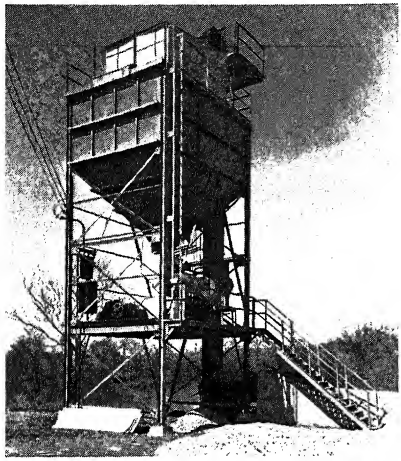
The "Package Delivery" plant is made possible by the use of steel plate construction, permitting complete assembly of tanks at factory at costs substantially lower than concrete construction for plants of like size and providing greater durability.

The two-stage treatment plant illustrated below is probably the first factory-fabricated "Package Delivery" complete treatment plant in this country or abroad. It was designed to treat the difficult wastes arising in a milk products plant. Many novel features are incorporated in various phases of treatment and the operation of these plants is substantially automatic.

For complete details of these plants, or for any industrial waste problems, consult us.



Typical "Package Delivery" Waste Treatment Plant



IROQUOIS Mixing End with 110 Ton, 4 Compartment Storage Bin and One Ton Mixer.

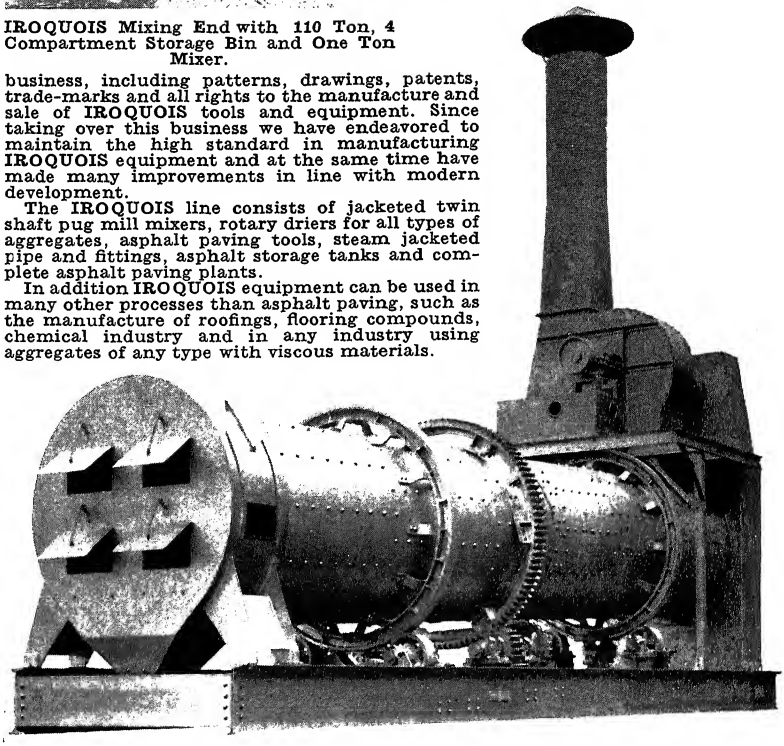
IROQUOIS DIVISION
ASPHALT PLANT EQUIPMENT

In 1870 when the first sheet asphalt pavements were laid in this country, proper tools and equipment for producing and laying these pavements were not available. The Barber Asphalt Paving Company, black top pioneers, were forced to design special tools and equipment for this purpose which resulted in the establishment of the IROQUOIS line. For over sixty years they experimented and developed the best tools and equipment which could be obtained. As a result IROQUOIS paving plant equipment and tools have been standard all over the world and represent the best in design, workmanship and materials.

In 1937 the Lancaster Iron Works purchased from the Barber Asphalt Corporation their entire IROQUOIS business, including patterns, drawings, patents, trade-marks and all rights to the manufacture and sale of IROQUOIS tools and equipment. Since taking over this business we have endeavored to maintain the high standard in manufacturing IROQUOIS equipment and at the same time have made many improvements in line with modern development.

The IROQUOIS line consists of jacketed twin shaft pug mill mixers, rotary driers for all types of aggregates, asphalt paving tools, steam jacketed pipe and fittings, asphalt storage tanks and complete asphalt paving plants.

In addition IROQUOIS equipment can be used in many other processes than asphalt paving, such as the manufacture of roofings, flooring compounds, chemical industry and in any industry using aggregates of any type with viscous materials.



66" x 30'-0" IROQUOIS Cold Mix Drier

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